A. III
Official

PROCEEDINGS

OF THE

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS

CONVENTION HELD AT

ST. LOUIS, MO.

OCTOBER 12, 13, 14, 15, 1920

TWENTY-SEVENTH YEAR

197915
22/9/25

VALPARAISO, INDIANA
CHARLES CARROLL BROWN
SECRETARY

CONTENTS

METHODS OF SNOW DISPOSAL
By H. S. Richards, Superintendent of Maintenance and Repair Division, South Park Commissioners, Chicago, Ill. (Illustrated) 1

TEN YEARS OPERATION OF A MUNICIPAL REDUCTION PLANT
By Walter D. Bee, Superintendent of Garbage Disposal, Columbus, Ohio........ 10

THE ST. LOUIS SEWER SYSTEM
By W. W. Horner, Chief Engineer of Paving and Sewerage (Illustrated)........ 12

DISCUSSION
By G. H. Norton and W. W. Horner........ 18

SEWAGE TREATMENT PLANT AT BRIDGEPORT, CONNECTICUT
By James A. McElroy, City Engineer (Illustrated)... 19

THE DISPOSAL OF TRADE WASTES
By Robert Spurr Weston, Weston and Sampson, Boston, Mass........ 33

DISCUSSION
By L. L. Tribus........ 38

THE MILES-ACID PROCESS ON TANNERY SEWAGE WASTE
By E. S. Dorr, Engineer Sewer Service, Boston, Mass. 42

REPORT OF COMMITTEE ON STREET LIGHTING
C. W. Koiner, Chairman, Pasadena, Cal. (Illustrated). 44

REPORT OF COMMITTEE ON PARKS AND PARKWAYS
John M. Rice, Chairman, Pittsburg, Pa........ 51 X page 5

THE MAKING OF REGIONAL SURVEYS
By Thomas Adams, Town Planning Adviser, Ottawa, Ont........ 55

THE ST. LOUIS CITY PLAN
By E. R. Kinsey, President of Board of Public Service........ 60

THE ZONING PLAN RECENTLY ADOPTED FOR WASHINGTON, D. C.
By Harland Bartholomew, Engineer City Plan Commission, St. Louis, Mo., Consultant Zoning Commission, Washington, D. C........ 64

THE RELATION OF ZONING TO THE WORK OF THE CITY ENGINEER
By E. S. Rankin, Chief Engineer of Sewers, Newark, N. J........ 70

PITTSBURG PROBLEMS IN CITY PLANNING DUE TO RUGGED TOPOGRAPHY
By N. S. Sprague, Chief Engineer, Bureau of Engineering, Pittsburg, Pa. (Synopsis) 73

TRANSPORTATION AND THE CITY PLAN
By Nelson P. Lewis, Chief Engineer, Division of Public Improvements, Board of Estimate and Apportionment, New York City 74

SUGGESTIONS FROM FRENCH PRACTICE IN MUNICIPAL IMPROVEMENTS
By George B. Ford, Director of City Planning Department of the Technical Advisory Corporation, New York City (Illustrated) 82

THE CONSTRUCTION OF PUBLIC BUILDINGS AND BRIDGES IN ST. LOUIS
By L. R. Bowen, Engineer of Bridges and Buildings (Illustrated) 88

HOUSING
By Nelson Cunliff, Secretary and Manager, Home and Housing Association, St. Louis 97

REPORT OF COMMITTEE ON TRAFFIC AND TRANSPORTATION
Arthur H. Blanchard, Chairman, Ann Arbor, Mich . . . 100

DISCUSSION
By W. P. Blair and A. H. Blanchard 105

RELATION OF THE PROPOSED UNIFORM VEHICLE LAW TO MUNICIPAL TRAFFIC REGULATIONS
By H. G. Shirley, Secretary of National Committee on Highway Traffic 107

WIDTH OF ROADWAYS FOR DIFFERENT CLASSES OF STREETS
By Robert Hoffman, Chief Engineer, Cleveland, Ohio 112

PAVEMENT FOUNDATIONS AS A FACTOR IN ECONOMIC TRANSPORTATION
By Robert C. Barnett, Economic Engineer, Kansas City, Mo. (Illustrated) 118

REPORT OF THE COMMITTEE ON FIRE PREVENTION
Alcide Chaussé, Chairman, Montreal, Que 134

FIRE PREVENTION AND FIRE FIGHTING
By Clarence E. Ridley, New York City (Illustrated) . . 137

MUNICIPAL FINANCES
By Louis Nolte, City Controller, St. Louis, Mo 140

REPORT OF COMMITTEE ON STANDARD TESTS FOR BITUMINOUS MATERIALS
A. H. Blanchard, Chairman, Ann Arbor, Mich 142

REPORT OF COMMITTEE ON STREET PAVING
W. A. Howell, Chairman, Newark, N. J 144

ASPHALT PRODUCTION, REFINING AND RELATED PROBLEMS
By Herbert Spencer, C. E., Standard Oil Co., of N. J., New York City (Illustrated) 157

DISCUSSION
By J. S. Miller, Jr., W. W. Southgate, W. E. Worcester, and H. Spencer 171

THE ELIMINATION OF UNNECESSARY TESTS FROM ASPHALT CEMENT SPECIFICATIONS: A PLEA FOR STANDARDIZATION
By R. R. Barrett, Engineer, Asphalt Sales Department, The Texas Company, New York City 172

PRESENT STATUS OF MACADAM BASE FOR BITUMINOUS PAVEMENTS
By Julius Adler, Deputy Chief, Bureau of Highways, Philadelphia, Pa 177

DISCUSSION (Illustrated)
By G. C. Warren 184

ASPHALTIC PAVEMENT CONSTRUCTION ON ILLINOIS STATE HIGHWAY AND CHICAGO BOULEVARD LINK
By John B. Hittell, District Engineer, The Asphalt Association, Chicago, Ill. (Illustrated) 189

ASPHALT BLOCK PAVEMENTS
By P. S. Thompson, Sales Manager, The Hastings Pavement Co., New York City (Illustrated) 201

THE PROTECTION OF GRAVEL ROADS BY SURFACE TREATMENTS
By Philip P. Sharples, Manager, Tarvia Department, The Barrett Company, New York City 209

TARVIA B SURFACE-TREATED GRAVEL FOR LIGHT TRAFFIC CITY STREETS
By D. B. Davis, City Engineer, Richmond, Ind 216

GRAVEL: A PLEA FOR COMMON SENSE SPECIFICATIONS
By Wallace F. Purrington, Chemist and Testing Engineer, State Highway Department, Concord, N. H 223

RECENT EXPERIENCES WITH WOOD BLOCK PAVEMENTS
By Hermann Von Schrenk, Consulting Engineer, St. Louis, Mo. (Illustrated) 227

DISCUSSION
By G. W. Tillson, W. Buehler, W. W. Horner, H. Von Schrenk, W. W. Southgate, J. Kendrick, E. R. Dutton and others 235

CONCRETE FOR MUNICIPAL PAVING
By Lt. Col. H. C. Boyden, Portland Cement Association, Chicago, Ill 240

PAVING BRICK AND BRICK PAVEMENTS
By J. C. Travilla, Consulting Engineer, Dunn Wire-Cut Lug Brick Co., St. Louis, Mo 247

BRICKS VS. BLOCKS
By S. Cameron Corson, Boro Engineer, Norristown, Pa. 253
EXPERIMENTAL PAVEMENTS IN THE BORO OF QUEENS
By Fred H. Shepheard, Assistant Engineer, and E. E. Butterfield in Charge of Tests, Long Island City, N. Y. (Illustrated) 255
THE WATER SUPPLY OF ST. LOUIS
By Francis T. Cutts, Assistant Water Commissioner (Illustrated) 265
THE PRESENT STATUS OF THE ACTIVATED SLUDGE DISPOSAL PROCESS
By Edward Bartow, Head of the Chemistry Department, State University of Iowa, formerly Director State Water Survey Division, Urbana, Ill. (Illustrated) 280
DISCUSSION (Illustrated)
By E. Bartow, L. Pearse, T. C. Hatton, J. C. McVea, and others 286
STREET LIGHTING IN ST. LOUIS
A discussion by Earl A. Anderson, R. Toensfeldt, J. M. Rice, H. Bartholomew, and T. C. Hatton 293
BUSINESS PROCEEDINGS 296
Address of Mayor Henry W. Kiel 296
Address of Vice-President R. Keith Compton 299
Address of President George H. Norton 302
Report of the Executive Committee 306
Report of the Secretary 310
Report of the Treasurer 315
Report of Committee on Nominations of Officers 322
Report of Committee on Place of Meeting 322
Report of Committee on Specifications for Sheet Asphalt Paving 325
Report of Committee on Specifications for Bituminous Macadam, Bituminous Concrete and Asphalt Block Pavements 331
Report of Committee on Specifications for Portland Cement Concrete Pavements 333
Standard Specifications for Portland Cement Concrete Pavements as adopted 333
Report of Committee on Specifications for Stone Block Pavements 338
Standard Specifications for Stone Block Paving as Recommended for Adoption 340
Report of Committee on Specifications for Sewer Construction with partial proposed specifications for materials 346
Report of Committee on Specifications for Wood Block Paving 359

Report of Committee on Specifications for Brick Paving 361
Report of Committee on Specifications for Sidewalks and Curbs 364
Standard Specifications for Concrete Sidewalks 365
Standard Specifications for Curbs 373
Report of Special Committee on Foundations for Pavements with proposed Specifications for Broken-Stone Foundations, Asphaltic and Tar-Bound Bases 381
Reports of Committees on Amendments to the Constitution 394, 395
Report of Committee on Resolutions 397
RESULTS OF LETTER BALLOT ON PROPOSED CHANGES IN SPECIFICATIONS 406
ATTENDANCE AT ST. LOUIS CONVENTION 408
EXHIBITORS AT ST. LOUIS CONVENTION 412
OFFICERS AND COMMITTEES FOR 1920–21 414

ADVERTISEMENTS

Alvord and Burdick 464
The Asphalt Association 432
The Barrett Company 430
Black and Veatch 464
The Blackmer and Post Pipe Company 456
The Buffalo-Springfield Roller Company 450
The Champion Corporation 458
The Diamond Labor Supply Company 448
The Dunn Wire-Cut Lug Brick Company 444
Fuller and Mc Clintock 464
The Granite Paving Block Manufacturers Association of the United States 446
The Harris Granite Quarries Company 448
The Highway Iron Products Company 464
Robert W. Hunt and Company 462
The Jennison-Wright Company 442
Edward E. Johnson, Inc 460
The Laclede Steel Company 462
The Pacific Flush-Tank Company 464
Alexander Potter 464
Public Works 458
The Republic Creosoting Company 440
The Sanitation Corporation 452, 453
The Standard Oil Company of New York 434
The Texas Company 436
Warren Brothers Company 438

MEMBERSHIP LIST

Active Members 421
Municipal Members and Their Delegates 435
Affiliated Members 437
Associate Members 439
Changes in Membership 459

NEXT CONVENTION
AT
SOUTHERN HOTEL
BALTIMORE, MD.
OCTOBER 24, 25, 26, 27, 28, 1921

METHODS OF SNOW DISPOSAL

By H. S. Richards, Superintendent of Maintenance and Repair Division, South Park Commissioners, Chicago, Ill.

At the present time, when passenger automobiles and trucks are numerous in practically all parts of the country, the importance of keeping the roads and streets in shape for their use as avenues of communication at all times of the year is a vital one to every community. And this is especially necessary in the northern part of our country, where for several months each winter traffic is impeded to a greater or less extent by snowfalls. In many districts a considerable part of the cross-country freight-carrying business is now done by auto-trucks instead of by the railroads, and any obstacle to their free movement from town to town is a serious detriment to the communities served by the trucks. When we consider the financial loss occasioned by a tie-up of but a day or two after a big storm, it soon becomes evident that the aggregate loss during an ordinary winter, due to snow-blocked roads, is a sum of large proportions.

That officials nearly everywhere are alive to the needs of practical, year-around thorofares for business reasons as well as for pleasure travel is evidenced by the enormous roadbuilding programs mapped out in the various states, on which in most cases work has progressed as rapidly as circumstances in each locality would permit. It would hardly be reasonable therefore to neglect any ways or means of keeping these roads and streets open for the needs of regular traffic thruout the winter months.

There are many practical difficulties, however, connected with the problem of snow removal, which might easily escape the notice of persons not experienced in this line of work. Inadequate or poorly designed equipment, scarcity of operators, the amounts and qualities of different snowfalls and whether drifted or not, density of traffic, entire removal of snow from crowded city walks and pavements, inability to cope with snowfalls on short notice and when most advantageously handled, either by day or night, are some of the main difficulties that try the mettle and patience of the official in charge of snow-removal work.

Take, for instance, the several kinds of snow and the peculiarities involved in handling each of them; the dry, feathery snow, the heavy, wet, soggy snow, the snow that may have had one day's thaw and become crusted on top over night, and the dry, ground-up, drifted snow; this latter piles up and packs like sand dunes and is especially difficult to move. When snow plows operate in light, feathery snow, the snow alongside of the plows, not being very compact, will readily give way to make room for the windrows delivered from the plow-blades. But the ground-up sandy snow, being already thoroly compacted, will not and cannot move over to make room for any from the ordinary plow-blade, unless there is an extraordinary reserve of power behind it. In such a snow, with ordinary equipment, the snow moved to open a passageway must be lifted bodily from its position and piled on that on either side.

In cities it is particularly desirable for several reasons to remove fresh snow before traffic packs it, but with the best laid plans it is sometimes impossible to accomplish this in time. And if permitted to pack, the snow becomes welded to the pavement under certain weather conditions, so solid as to resemble ice. When in this condition it must usually be tackled with picks and removed by hand labor. If allowed to remain, the traffic following a certain line will form ruts, which soon become worn thru from the use of nonskid chains on automobiles and then the pavement underneath receives undue wear, making costly repairs necessary in spring. However, with every winter, profiting by previous experience, our methods and equipment are being improved so as to handle our problems more effectively.

I will now describe briefly the snow-removal methods and equipment of the South Park Commissioners of Chicago. These were developed after an experience of fourteen years of snow-disposal work on many miles of boulevards and park drives, some running thru the heart of the loop, which is the city's busiest district, where automobile and foot traffic is quite congested thruout the day, but particularly so at certain hours in the morning and afternoon or early evening. The areas covered by the Park Commissioners in snow-cleaning work include about 67 miles of drives, 175 miles of walks, and from 90 to 95 acres of skating ice. Of course the main arteries of travel are cleaned first, the work being then extended as fast as possible to the balance of these surfaces. The above areas are spread over a territory twelve miles long and seven miles wide.

There are, first of all, 23 teams of heavy draft-horses owned by the Park Commissioners, most or all of which are used for plowing snow when occasions so demand. These teams draw four-wheeled road-graders, which are fitted with mold-board plow-blades, about fourteen inches high and seven feet long, so hung that the angle of cut can be changed to accommodate weight and depth of snow. The park teams are supplemented, if need be, by hired teams pulling plows of the road-grader type. The teams are sent out from the park stables (which are located near the park offices and about eight miles from the loop) in different groups. Each group consists of from six to ten teams, depending on the depth of snowfall; each is in charge of a leader and a definite territory is assigned it for plowing. The first assignment of each group consists of six to eight miles of drive, and when this assignment is completed additional work is given. The teams plowing on the drives work one a little behind another in a line at an angle with the curb, plowing the snow from the center of the drive to the gutter.

Each group moves with the traffic, working on the right half of the road. In snows four inches or less in depth one team on a grader leads the way near the center of the drive, the other teams and graders following in the diagonal line which extends to the curb; the last grader usually has two teams, as the draft on it is heavier, inasmuch as it is called upon to move the windrow of snow delivered from the plows before it in addition to its own swath. In snows five inches or more in depth, each grader-plow has two teams, except the first, on account of this increased draft. If plowing can be done shortly after a snowfall, one round trip will clean a drive pretty thoroly from curb to curb, but if the snow has been somewhat wet and has been packed, then additional trips are necessary to scrape off the packed snow next the pavement, which resisted the plows on the first trip.

1. *Rotary Snow Plow in Operation*

With many miles of driveways to clean, teams moving at a rate of four miles or less per hour will not cover very much mileage soon enough after a snowfall to prevent it from being packed by traffic, as ordinary traffic does not suspend operations, awaiting the cleaning away of snow, unless compelled to do so by excessive depth or drifts. Therefore our teams have been usually assigned to those boulevards that are least used just after a fall of snow in order to give them time to open the drives before too much traffic passes over the snow to pack it firmly. While the teams and grader plows may lack in speed, they certainly do remove the snow very cleanly and efficiently.

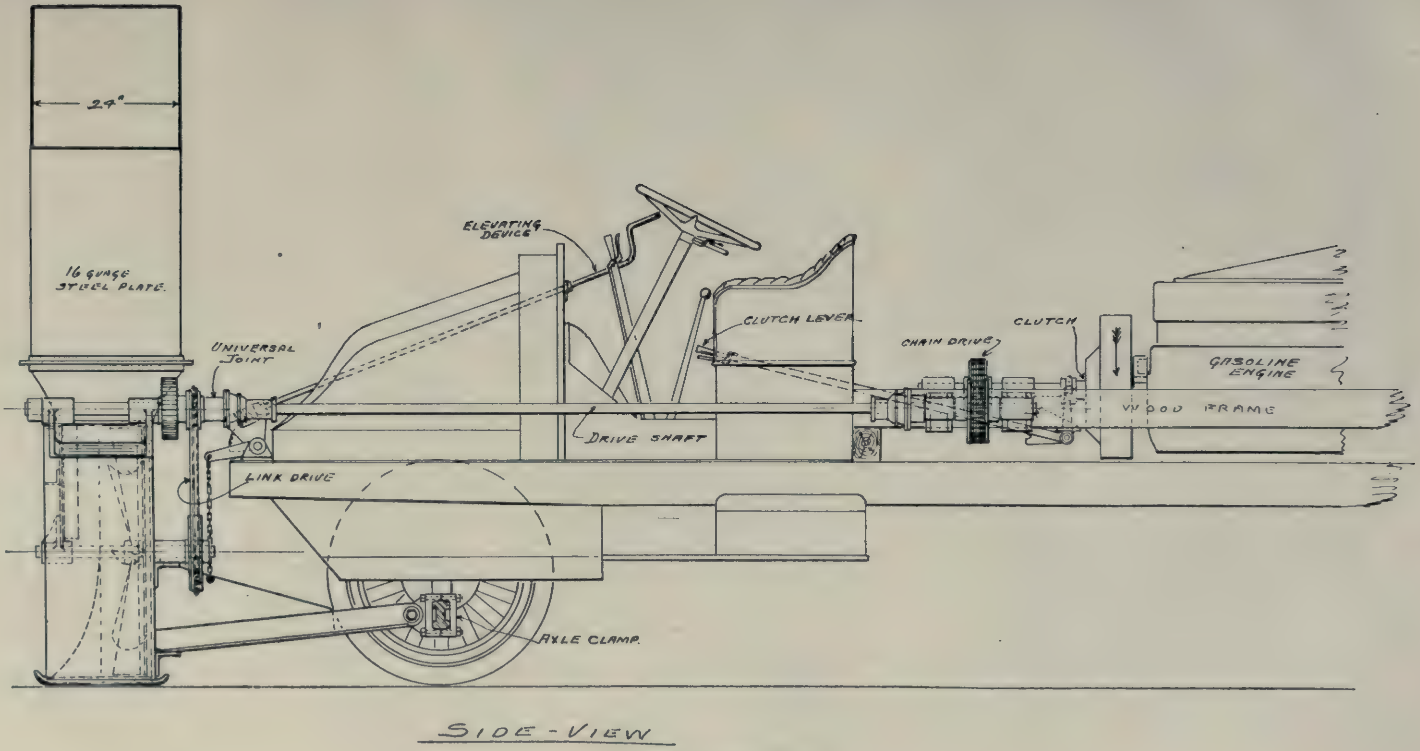
Other teams, mostly hired ones, are sent to plow snow off the principal walks with plows of the road-grader type as soon after each snowfall as possible to get them started. These teams go singly. As soon as teams are available, which is ordinarily after the cleaning of walks is completed, they are sent out to clean the larger fields of skating ice. Thus all the facilities where service was impeded by the snowfall are re-opened to the public.

For work on the principal boulevards, auto-trucks are used; each of these is equipped in front with a mold-board plow, so fitted that it can readily be put on and removed as desired. During the last two winters arrangements were in force with two contractors having a large number of heavy auto-trucks, whereby they furnished twelve trucks and drivers for plowing snow on short notice at any time of day or night. These trucks were operated in four fleets of three trucks each. A certain territory was given to each fleet, the machines working one a little behind another, in a line at an angle with the curb, the same as the horse plows. They moved with the traffic, going on one side of the drive and returning to the starting point on the other, all the time plowing the snow from the center of the drive towards the gutters.

As soon as snow fell to the depth of half an inch, with prospects of a continuing fall, the auto-trucks were called out and made trips over their drives while the snow was falling and until the snow was entirely plowed back to the gutters. Except in heavy falls, the trucks had completed their work shortly after the snowfall ended. With heavier falls of snow the plowing of necessity was not finished quite as soon. Each fleet of trucks was given from six to eight miles of drives to clean, and they were usually able to travel at an average speed of ten or twelve miles per hour, making a round trip over their territory every hour or so. In this way the snow did not get a chance to accumulate to any great depth between rounds and it was not unwieldy handling for the trucks. The trucks were hired by the hour, each truck being allowed a certain number of hours as a minimum for every time they were called out. The mold-board plow attachments were furnished by the Park Commissioners and stored in the contractors' garages, so as to be on hand when needed.

The Park Commissioners own a number of tractors and heavy trucks which are also used for plowing snow when required. These include five three-wheeled tractors fitted with detachable V-shaped plows having wing extensions and with detachable, revolving street-brooms, one four-wheeled tractor equipped with both V-shaped and straight mold-board attachments and five heavy trucks. The revolving street-broom attachments are for use in light, feathery snow, for brushing after plowing, if desired, or for cleaning walks.

Part or all of the Park motor equipment is sent out, if enough operators are secured, shortly after a snowfall begins, to fight it while it is in progress. These machines are divided into fleets, or if only a part of the equipment is sent out it may operate in one group, and is given a certain territory. After snow has ceased falling and any fleet of plows, either park-owned or hired, has finished its plowing, the foreman in charge of motor-plows sends that fleet elsewhere in the park system, wherever most needed.



2. Rotary Snow Plow

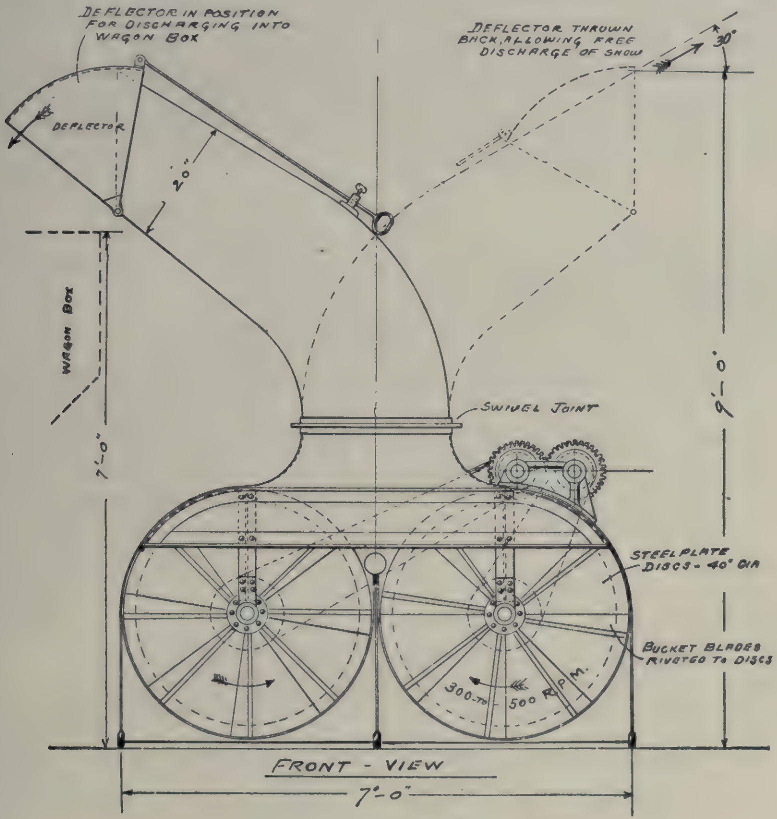
This system of handling the snow-removal work has so far proved more satisfactory than any tried heretofore.

During severe blizzards combining heavy snowfalls and continuous high winds it has been practically impossible to prevent the formation of deep drifts of ground-up sand-like snow on stretches of drives on the boulevards and in the larger parks. Opening these stretches of blocked drives was a most difficult proceeding, as motor-plows invariably got stalled in them and could make but little headway. If horse-drawn graders were used it was also a slow proceeding, but could be accomplished. I will relate an instance of this sort.

In January of 1918 a particularly severe storm blocked parts of Michigan Avenue Boulevard with dry, sandy snow. At some places the snow was several feet deep on the level for a block or more and drifts five feet deep were frequently encountered. The motor-plows, from which we could usually expect fairly rapid and efficient service in ordinary snow storms met their Waterloo, became stalled in the drifts and were compelled to give up the battle. Straight mold-board attachments on motor-trucks proved no better than the V-shaped plows on tractors. This left us with the slowly drawn road-grader horse-plows as our only means, aside from hand-shovel work, for opening passageways thru the tightly packed and badly drifted snow.

Wherever it was possible for horses to travel, the grader-plows with blades set at a sharp angle with the line of travel, followed and cut openings thru the snow. It was a frequent occurrence to be obliged to dig the horses themselves out of the drifts in which they became stalled. Progress could only be made by using four horses on a grader, and at first we found fourteen such grader outfits necessary to open a passageway thru the drifts along the boulevard wide enough, after one trip of the plows, to permit an automobile to make its way thru. Altho the plow-blades were set so each grader cut as narrow a swath as possible, in order to lighten the draft upon the teams, even then seven of the graders had to be sent ahead to break a way thru the top part of the snow, the other seven coming behind and cutting down to the pavement. Later, when more headway had been made, these narrow passageways were widened by hand-shoveling in order to allow two machines to pass each other. For a while about five hundred laborers were busy with large shovels opening drives and walks thruout the park system. This work was exceedingly wearing upon the park draft-horses; they came in at night with heads hanging low, all wet with perspiration and apparently over-fatigued. Altho thirty-seven large drive-cleaning plows were in service in addition to smaller ones, with all the hired teams we could secure for miles around, the progress was at times discouragingly slow. At times business houses along some of the boulevards assigned employes with shovels to assist us in opening paths before their business places. At such times the cleaning of skating ice was necessarily postponed until the travel thorofares were made passable.

On our downtown boulevards, all of the snow from walks and drives for several miles must be entirely removed from the premises; this is accomplished by hauling it to a dump near the lake shore by wagon or truck, the haul ranging from one-half mile to one and a half miles. Such hauling of snow is not done, however, until it has been plowed into windrows, and passages for traffic have been thoroly opened. In some cases very large snow-wagons holding about fourteen yards each were used, drawn by our tractors, and by a special arrangement were emptied in a fraction of a minute.


DEFLECTOR IN POSITION FOR DISCHARGING INTO WAGON BOX
DEFLECTOR THROWN BACK, ALLOWING FREE DISCHARGE OF SNOW
30°
DEFLECTOR
20"
WAGON BOX
7'-0"
9'-0"
SWIVEL JOINT
STEEL PLATE DISCS - 40" DIA
BUCKET BLADES RIVETED TO DISCS
300 TO 500 R.P.M.
FRONT - VIEW
7'-0"

3. *Rotary Snow Plow*

The chief difficulty in handling snow of the kind mentioned above seems to be its packed, unyielding condition. V-shaped plows having a spread of eight feet or so must shove the snow sideways to open a passage for the plow, but this cannot be done in such snow. Mold-board plows set at a sharp angle are able to cut a narrow opening, but with difficulty. A cut in snow of this character can theoretically be best made by lifting some of it upwards and throwing it over the adjacent snow on either side, thus eliminating the necessity of any side movement while the snow is in its original position.

With this thought in mind was designed and built early in 1919 a rotary snow-plow operated by a tractor, and it was put thru a series of trials that year and in 1920 with very gratifying and promising results. No snow seemed too much packed for its operation and ordinary four- or five-foot drifts were no hindrance to it at all. The machine was fitted with an adjustable spout to control the stream of snow as it left the plow, so that it could be thrown to a considerable distance from the drive, piled along side of the curb or loaded into wagons. At times the delivery of snow thru this spout was so great that a three-yard wagon could be filled in about a quarter of a minute. This type of machine would be ideal for country-road snow-removal as it could cut its way thru any ordinary drifts quite readily and could throw the snow over the fences into the fields where it would not be easily blown back into the cleaned roadway.

In June of this year (1920) a census of traffic was taken on the downtown part of Michigan Avenue. In the effort to secure a normal census a time was chosen when no conventions nor special programs of any sort were in progress. But as the weather during the week of the census was quite cool, the thermometer never registering above 59 degrees, the results of the census are somewhat below normal, because warm or hot weather in summer invariably increases the number of machines in operation.

The figures for one day of the census, Friday, June 18, 1920, are given below, the number of vehicles passing north and south along Michigan Avenue at 12th Street during every hour for the twenty-four hours beginning at 8:00 A.M. being as follows:

Hour	Vehicles	Hour	Vehicles
8 to 9 a. m.	2,396	8 to 9 p. m.	2,315
9 to 10 a. m.	2,413	9 to 10 p. m.	1,852
10 to 11 a. m.	2,670	10 to 11 p. m.	1,773
11 to 12 noon	2,573	11 to 12 midnight	1,588
12 to 1 p. m.	2,594	12 to 1 a. m. (June 19th)	1,070
1 to 2 p. m.	2,547	1 to 2 a. m.	730
2 to 3 p. m.	3,180	2 to 3 a. m.	484
3 to 4 p. m.	2,895	3 to 4 a. m.	245
4 to 5 p. m.	3,189	4 to 5 a. m.	153
5 to 6 p. m.	3,290	5 to 6 a. m.	146
6 to 7 p. m.	2,086	6 to 7 a. m.	269
7 to 8 p. m.	1,714	7 to 8 a. m.	1,129

Total, both directions, for 24 hours..................43,301

These figures show an average traffic of from 2½ to 55 vehicles per minute, depending on the hour of day or night. A traffic density only partly as heavy as this hampers snow-cleaning work considerably. A snowfall occurring at certain hours of the day is soon packed so as to make its removal most difficult. It is our aim to get the plows busy promptly when snow is falling and prevent as much packing as possible. While the traffic on outlying boulevards is lighter than that on Michigan Avenue and Jackson Boulevard, it is nevertheless a factor that must be promptly reckoned with in our work.

Snow-removal work in general presents problems quite difficult of efficient solution. In my opinion a great deal of experimentation under actual working conditions will be necessary to develop snow-handling equipment that will prove reasonably satisfactory for the varying requirements of this line of work. With the necessity for a proper solution to this problem becoming more acute or pressing every winter, we may feel that it will be mastered in the not-distant future, with results that will be heartily welcomed by those in charge of snow-cleaning work thruout the country, and by the business people and general traveling public as well.

TEN YEARS OPERATION OF A MUNICIPAL REDUCTION PLANT

By Walter D. Bee, Superintendent of Division of Garbage Disposal, Columbus, Ohio

To prevent any misunderstanding about the various points to be considered in this paper, a brief outline of the process of garbage disposal as practised at the Columbus plant, is first in order.

The garbage is first cooked with live steam, then pressed thru continuous roller-presses. Tank-liquor and grease from the presses goes to the grease-separating tanks and from these to storage. Tank-liquor is drawn from storage as needed and passed thru vacuum evaporators. Solids from the roller-presses go thru the first dryer, and then to the percolator for final de-greasing with gasoline. After percolating, the tankage is mixed with all the stock-liquor it will hold, and again dried, the final operation being sizing and grinding.

The first point to be covered is the manner of drying the tankage so as to produce a merchantable article. At the Columbus plant, the tankage is dried twice, as above noted. As it comes from the presses, the tankage contains from 65% to 75% moisture. This moisture content is reduced in the first drying to about 10% or 12%, or dry enough for the material to be "wetted" with gasoline.

After final de-greasing with gasoline, the tankage is passed over a one-half-inch-mesh screen, all material too large to go thru the openings being rejected as of no further value. That which goes thru the screen is then conveyed to the mixer, where enough stick-liquor is added to make the mixture so thin that it will "run" rather than "pile up." This makes a pretty wet product to dry in one operation, but we do it in a direct-heat dryer, and the tankage comes out as a hard granular substance with an average of about three percent moisture.

It has been our experience that the mixing is the particular place where both the quality and weight of the finished tankage may be most easily influenced. The more stick that can be added, the better and heavier will be the tankage. The average annual analysis of Columbus tankage runs about 3¾% ammonia, 1% potash and 7½% bone-phosphate, and we receive very few dead animals to help boost the ammonia.

Since learning the importance of the stick in the finished product, we have been able to command a better market at a much higher price than is obtained for other tankages which have not been so carefully manufactured. In fact, we are at present getting almost as much per unit as is being paid for high-grade animal tankage.

The second point to be discussed is that of solvents and their recovery. Gasoline has always been used at the Columbus plant, and up to the time this country entered the war there was no particular difficulty in securing the grade desired. During the war, however, we had to take what we could get, and be glad we got it, the result being that there was considerable loss of solvent due to high boiling points.

Last year, and this, we have been able to get a good grade of gasoline by carefully specifying what we wanted and then distilling a sample from the car to see if it was up to specifications. As our own power-plant operates at 115 lb. steam pressure without superheat, we are limited in the temperature we can obtain in the percolator when "steaming out."

We specify a straight-run gasoline which will distill off at least 95% at 300 degrees F., and then watch the car sample to see that the distillate comes off reasonably uniform. Ordinary motor-car gasoline does not distill readily with steam heat, and in addition is not nearly so good a grease solvent as the "high-test" variety. Our loss of solvent averages a little more than a gallon per ton of garbage treated, and has varied considerably from year to year, due to condition of plant and grade of gasoline used.

As a last point for discussion, I believe a short review of general garbage conditions during the last ten years in Columbus, will be of interest.

Up to, and including, 1916, the City collected garbage once a week during cool weather, and twice a week thru July, August and September. Beginning with 1911, the garbage increased from 190 lb. per capita to 218 lb. in 1915. In 1916, the last year of twice-a-week summer collections, the decrease started with 203 lb. per capita. Since 1916, collections have been on a weekly schedule thruout the year, and the slump continued to 1918 with a per capita of 138 pounds. Last year showed an increase to 157 lb., and this year promises to add a further substantial increase.

That the quality of garbage is best indicated by its grease content, is shown by the fact that we have been able to hold the tankage-production almost uniformly at a bit more than 10% of the green-garbage weight. We feel that the quantity of tankage that can be produced from a ton of garbage depends more upon the care and completeness of manufacture than on the richness of the garbage.

Taking this fact as a basis, I do not believe that the quality of the garbage varied much from year to year until 1916, when wages had advanced considerably, but commodity prices had not, as yet, gone up in proportion. Previous to 1916, grease recoveries were fairly uniform at about 2½%. In 1916 more than 3% of grease was obtained. Since then, grease recoveries have decreased until last year less than 2% was produced. So far this year the quantity of grease secured indicates that the low point was reached in 1919 and, with a further decline in the prices of food, the grease content or richness of the garbage should slowly increase.

THE ST. LOUIS SEWER SYSTEM

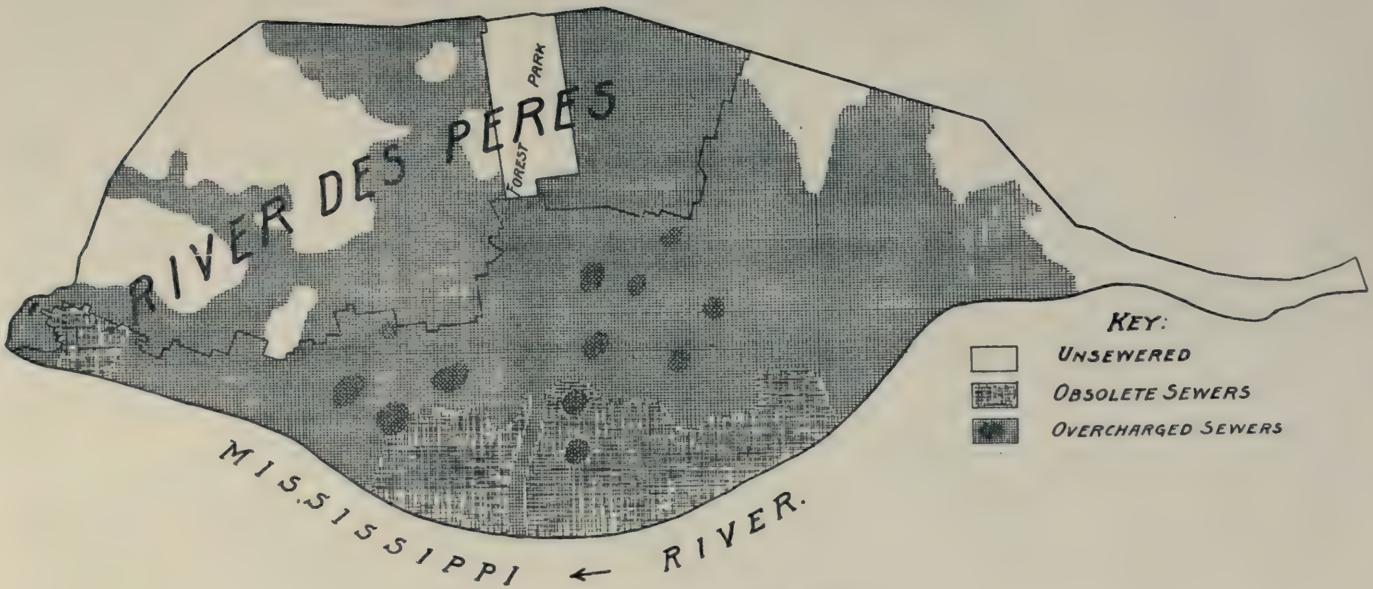
By W. W. Horner, Chief Engineer of Paving and Sewerage

In 1848 the mayor of St. Louis in the annual message said, "I desire to remark that in my judgment the time is not far distant when a different method will be adopted for the drainage of the city. The want of proper sewers is now a serious cause of complaint on the part of our citizens. The subject is now exciting attention and inquiry. St. Louis is favorably situated for the construction of sewers. But at the present time our finances will not admit of the expenditure. I recommend, however, that this subject should be kept steadily in view in all the street improvements hereafter made. Sewers are so essential to cleanliness, and contribute so largely to comfort and convenience, that their construction in this city cannot and will not be long delayed. If the public mind is not now prepared to sanction the undertaking, it will soon be.—Of this I have no doubt." His appreciation of the situation was evidently good, for the following year the state legislature passed an enabling act permitting the city to issue bonds for sewer construction, and to levy a tax, not over fifty cents on a hundred dollars, to pay off the debt.

Before a great deal had been accomplished the city received another severe lesson in the value of sanitation, as is brought out pertinently in the message of the mayor of 1851. "The present year, like the two preceding, has been marked by occurrences well calculated to retard our advancement. Just recovering from the effects of the great fire of 1849, and the epidemic of that and the succeeding year, we have had, the present season, a flood in the Upper Mississippi and the tributaries, nearly equal in height to that of 1844, and even more injurious in its consequences, from its longer duration, which has been seriously felt in the interruption of commerce, and the loss and inconvenience to our citizens, whose habitations and places of business were overflowed. In addition to this we have suffered, though in a less degree than in the two previous years, from a third and, as we humbly hope, the last visitation of the cholera."

St. Louis was founded on a sloping hillside, and the early city was only about four blocks deep and extended along the river. Its rainfall was carried off in the gutters, and was first enclosed in sewers across the levee, which was the scene of the city's most important development.

Back of this river-front slope, the present city lies in a series of valleys, generally trending from west to east, and now includes a large part of the River des Peres valley, which circles the city on the southwest. As the city grew it spread westward up these valleys. This situation was of great advantage for the builders of the earlier part of our sewer system, as it was only necessary to



1. *Condition of St. Louis Sewers*

sewer each valley to the extent of the city's development at that time, and the upper ends of the valleys being always rural, presenting no sanitary problem, and yielding comparatively small storm floods, permitted our development under almost ideal conditions. Thus for nearly fifty years our construction was a steady westwardly progress, paralleling the growth of the city, and each additional mile of main sewer indicated distinctly the progressive development in the art of sewer construction.

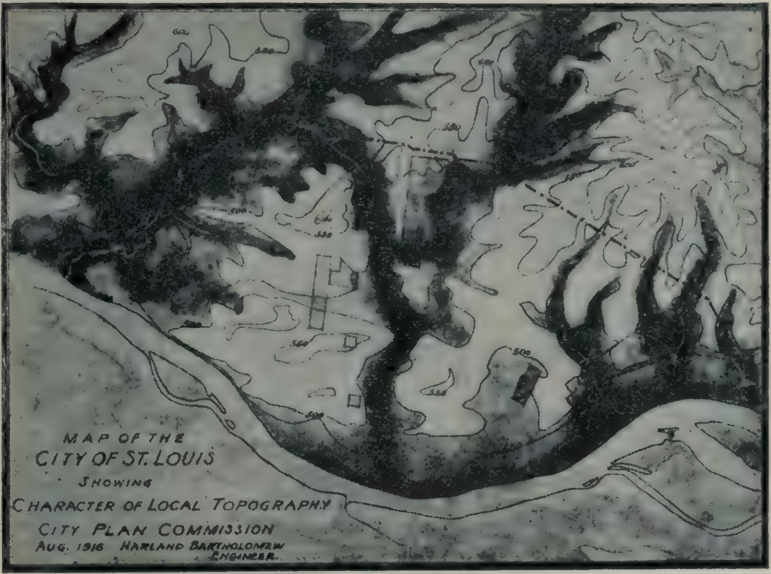
These early sewers were of two kinds, main trunk sewers, built almost entirely of cut stone, with some examples of cut stone side walls, and brick arches. In soft ground, these had timber bottoms of extraordinary construction, in some cases consisting of 12 by 30-inch cottonwood logs 30 feet long, laid side by side. The smaller sewers were at first all built of brick, generally of an egg shape in the smallest sections, and circular in the larger ones. The minimum size of brick sewer was 3 feet high by 2 feet wide, and the greater part of our old city, east of Jefferson Avenue, has sewers of this character, being 2 by 3 brick to the extreme ends. About 1870 some cement pipe was used, in sizes from 12 to 24 inches. This was discontinued about 1875 in favor of tile pipe, and the tile was used in increasingly larger sizes up to the present time, when 30-inch is common, and 36-inch used.

Eventually, however, we have had to pay the penalty for our earlier advantage of progressive construction. Our progress reached the heads of the valleys and they were completely occupied. They were also completely sewered, but the systems were not comprised in a single engineering design as we would lay them out today. Instead, near the river in each valley there were old sewers, inadequate in size and flimsy in construction, and at the upper end modern sewers built, both as to capacity and strength, according to the best standards that we have been able to develop. The intermediate construction represented the gradual progress of the art of sewer design and building thruout the city's development.

In the central portion of the city our progress passed over the ends of these eastern valleys into the valley of the River des Peres, and without providing any great improvement for that stream itself, we have sewered in detail much of the River des Peres valley out to our western limits. In the northwestern and touthwestern parts of the city our development has now reached so the city limits, and is only now requiring the final sewering of these outlying districts.

Under these circumstances it is obvious that the great problem of sewer work today is the relief of the early trunk sewers and the east ends of the mains in each valley. A study of one of these systems would show portions based on widely different theories of design, and with the personalities of many city engineers and designers impressed on them. Some interesting records of engineering opinion along this line are preserved in the early reports.

In 1852 the city engineer said, "I have constantly urged the reduction of our common sewers. I regret to see that private drains are generally made too large, and in midsummer I apprehend that they will be found unclean. It should be borne in mind that small sewers are stronger, cheaper, and more likely to keep clean. It is true they might be made too small, but we have in no instance so reduced the dimensions as to come below ample capacity. I have much reduced the size of the Seventh Street sewer, but not until I had carefully observed the quantity of water and calculated the capacity of a sewer requisite to issue such a flood." He then goes on to explain at length the mathematical formula resulting from the study of the mechanics of flow. He ends by saying that "public anxiety may therefore rest assured that if sewers fail it will not be in consequence of their being made too small." It is interesting to note, however, that the engineer failed to visualize the city which was ultimately to be served, and most of his sewers have now from thirty to forty percent of the required capacity.



2. *St. Louis Drainage Topography*

During a later development Mr. Robert Moore evolved a new table for sewer design, in which the sewers were to carry off one inch of water per hour, and at no time to run over three-fourths full. He says "This is equal to a natural rainfall of two to three inches per hour, depending upon the declivity and the character of the soil." Compare this with our present design, providing for a runoff of from two to three inches an hour.

At a still later date, Mr. Robert McMath made careful gagings of the flow of the St. Louis sewers, and developed the now famous "McMath Formula," which represented a great advance in sewer engineering, but which we have again been forced to discard in favor of the more satisfactory "rational method."

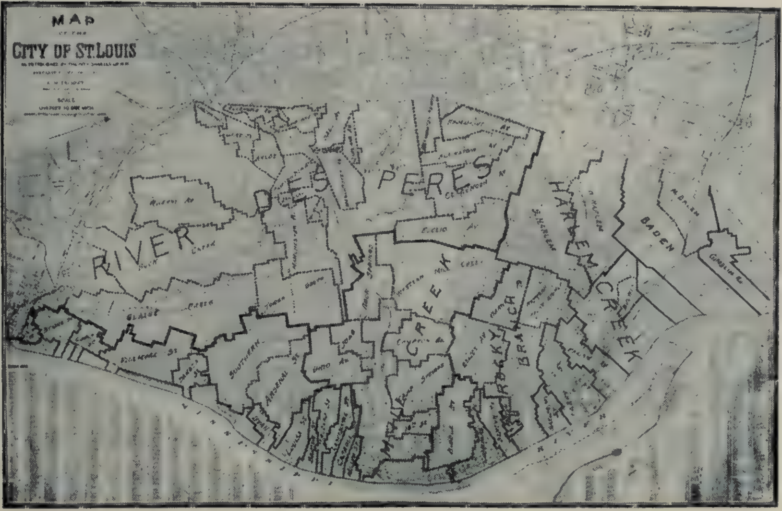
About 1885 the overcharge of the early sewers began to cause serious damage, and supplemental sewers were built in what is now the business district. In 1900 and in 1904 enlargements of the two main valley sewers, that is, the Mill Creek and the Rocky Branch, were carried out, but gave only temporary relief, and in 1910 and 1914 paralleling sewers were constructed to bring the total main-trunk capacity up to the amount required under modern conditions.

In all of this later work there has also been a general change in the character of the materials of construction, concrete and reinforced concrete coming into use for large sections, making possible the carrying out of great projects at half the cost of the old massive masonry structures. The reinforced concrete sewers of the Harlem Creek system were probably the first extremely large sewers in the country, and the Harlem system, as a whole, probably still stands as the largest single reinforced-concrete sewer, its sizes being from 29 feet in horizontal diameter down to 12, and the total length of the system in excess of 7 miles.

The sewer problem in St. Louis, while complicated in detail, is fortunate in the absence of any disposal problem. The low-water flow of the Mississippi river is 40,000 cubic feet per second, or over 50 cubic feet per second for each thousand of population at present. The problem really, therefore, is one of handling enormous amounts of storm water, and of carrying the sewage in the same conduits without creating offense. This can be appreciated from the capacities of the Harlem Creek sewer and of the relieved Mill Creek Sewer, which in each valley will carry 5,000 cubic feet per second. At the present time we are seeking for funds to continue the enlargement of the earlier sewers, and to replace some of the original brick sewers which are now in dangerous condition. A bond issue of $2,500,000 for this purpose failed to carry this year by a very small margin, and undoubtedly an issue for a larger amount will be voted shortly.

Our problem of sanitation of the River des Peres valley is the largest and most complicated which we have yet had to solve, and any satisfactory solution involves very great expenditures. The flow of this stream in full flood exceeds the low-water flow of the Mississippi river, and portions of the stream, which it seems necessary to carry in conduit, will have a flood flow of fully 10,000 feet per second. The plans for the work are complete and work will undoubtedly be begun in the next three years. The estimated cost of the whole project is $14,000,000.

The cost of our sewers has from the beginning been divided between the general public funds in the construction of public sewers, and the individual property holders in assessment by special tax. District sewers were paid for by bond issue guaranteed by the city, and refunded from the special annual tax, not exceeding fifty cents on the hundred dollar valuation. At a later date this was amended, and special tax bills for the full amount of the contract were issued to the contractor for collection. This latter system continues today, and while it absolves the city from any responsibility in its payment, it also makes the issue of tax bills particularly liable to contest and litigation, and their value has, therefore, considerably depreciated. A return to the earlier system, or of special tax bonds, would be an advantage.



3. *St. Louis Sewer Districts*

The growth of the system, together with its cost, is shown in the following table. Of the area within the present city limits, 64 percent is now completely sewered, and an additional 12 percent is provided with main sewers. Of the 23 percent unsewered, about 5 percent is in parks, so it will be seen that the city is in a very satisfactory sanitary condition, our one great problem, as mentioned before, being the sanitation of the River des Peres valley.

Of the total cost of the sewer system to date, 31 percent has been paid from public funds, and the remainder taxed directly against the property.

Table I

	Acres	Miles	Cost	Cost per acre
1855	400	18	$525,000	$1,310
1877	3,720	180	$5,185,000	1,390
1899	11,530	487	$9,248,400	802
1920	23,700	878	$23,512,000	990

The figures of cost per acre for sewerage are interesting in showing a steady decrease thruout the seventy years of the system's existence. The value for 1877, $1,390 per acre, is probably unbalanced, due to the fact that it came at the end of a period of very heavy main sewer construction, with a comparatively small acreage chargeable. Of the cost of the system to date, that is, $23,512,000 nearly $5,000,000 is chargeable to relief sewers, with which there was no corresponding additional acreage. If no relief sewers had been built, the cost per acre would now average less than $800. This simply means that with the demand for increased service, with the provision of greater capacities and more closely built areas, we have still been able to decrease our unit cost by the introduction of modern economical methods. These decreases are undoubtedly due primarily to the use of mechanical excavators, to the introduction of reinforced concrete in large sewers, and to the decrease, up to 1915, in the cost of factory-made materials.

DISCUSSION

PRESIDENT NORTON: If you will permit, the Chair would ask a question in regard to the concrete pipe sewers used here in the early days. In Buffalo, we have about two miles of concrete pipe and we do not know where it came from. Does Mr. Horner know where that came from?

MR. HORNER: I have been unable to get any information on that. We have recently taken up some of that pipe and found it in good condition.

PRESIDENT NORTON: We have found a number of those old sewers, laid probably in the '60's, comparatively thin, but good concrete.

SEWAGE TREATMENT PLANT AT BRIDGEPORT, CONNECTICUT

By James A. McElroy, City Engineer

The city of Bridgeport, which extends for about four miles along the north shore of Long Island Sound, has an area of about 18 sq. miles and a population of 150,000. There are five tide-water arms of the sound extending into the land area from one to two miles, of which the most important is the Pequonnock river, flowing thru the center of the city.

About 15 years ago the city government, realizing that the sewer system of Bridgeport needed a thoro investigation, appointed the firm of Hering and Fuller to study the subject and recommend a plan for the city to follow in building all future sewers. They reported in 1908 and since that time all sewers have been built in accordance with their general plan.

Up to that time all sewers had been built on the combined system. These sewers all emptied into the nearest tide-water, and in many cases were greatly overloaded.

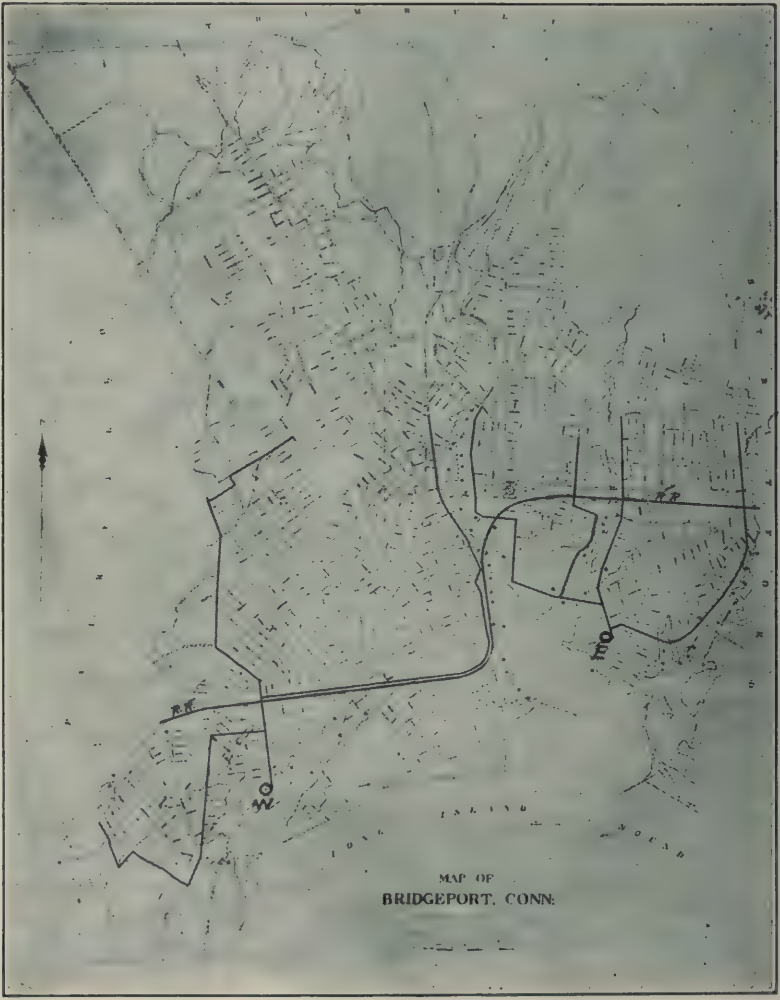
It was evident to the engineers that the city could not continue indefinitely emptying sewage into these small streams, some of which were hardly more than mud flats at low tide, and that some time it would all have to be collected and discharged into the sound either with or without treatment.

They also saw that on account of the large areas of low land along the shore it would be impossible to collect the sewage and deliver it either to outfalls or disposal works, without pumping. To collect large quantities of storm water in combined sewers and then pump it, would greatly increase the cost of construction of the trunk sewers, also the pumping cost, so Hering and Fuller recommended separate sewers for rain-water where possible, with storm-water overflows in some of the older sections of the city where the combined system would have to be retained.

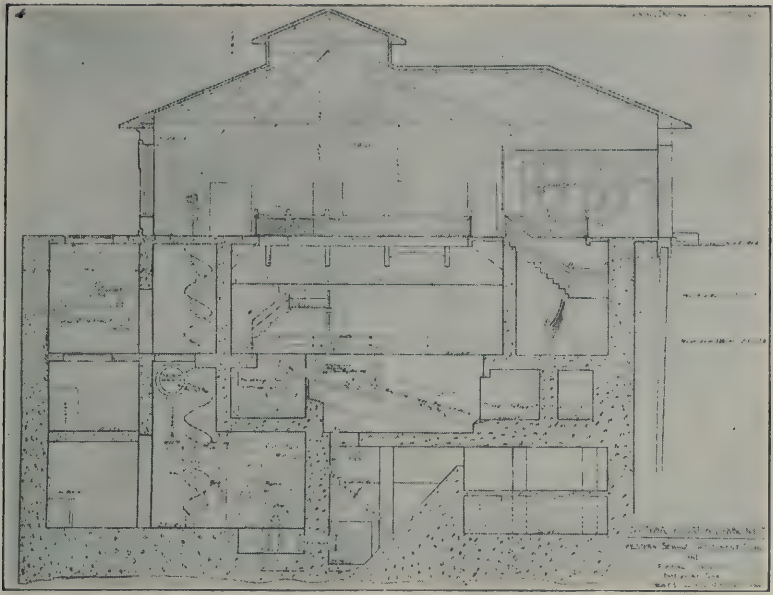
As the city was naturally divided into two districts by the Pequonnock river they planned a pumping station and system of intercepters for each district. It was their opinion that by carrying the outfalls to deep water no further treatment would be necessary, but they suggested that when sites were acquired for the pumping stations, sufficient land be secured to enable the city to build treatment plants, if desired at some future time.

For the next five years very little was done towards carrying out the recommendation of Hering and Fuller regarding the pumping stations and large intercepters; but in 1913 the city was compelled by the Superior Court to take action. Several property-owners brought suit against the city, complaining that the sewage in the Pequonnock river caused such a nuisance that the value of their property was materially affected. The court decided for the plaintiffs and ordered the city to build the Knowlton street trunk-sewer on the east side and the Housatonic avenue trunk on the west side of the river.

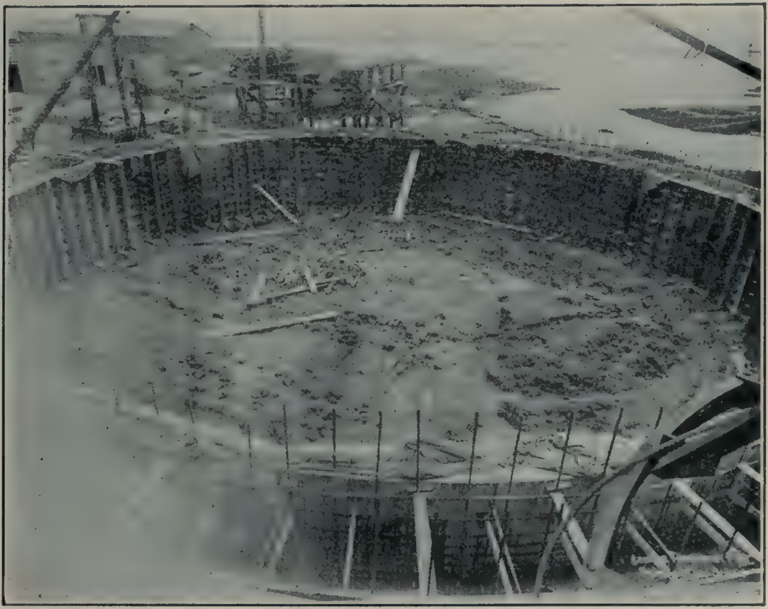
By 1916 all intercepters had been completed down as far as the sewage would discharge by gravity. No further extensions of the intercepters could be made until the pumping stations were built.



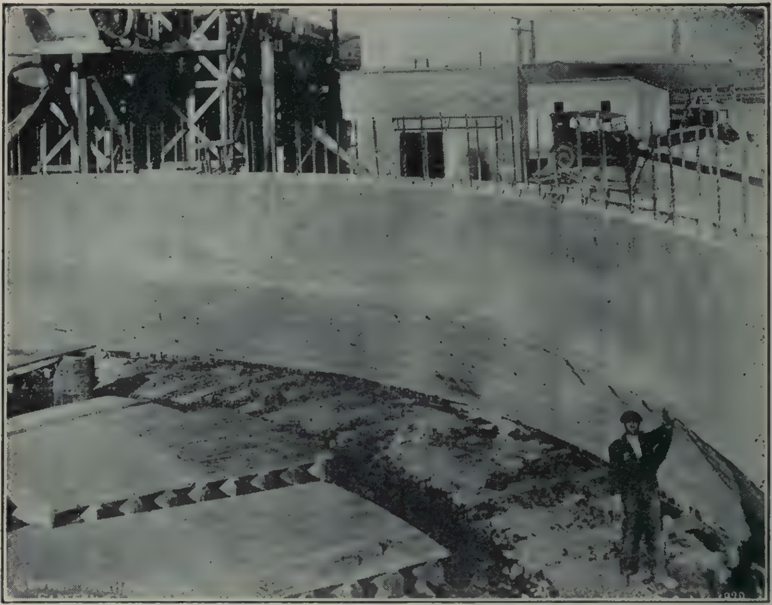
1. *Eastern and Western Sewerage Districts*
   E. Proposed location of Eastern District Pumping Station.
   W. Western District Pumping Station.
   **Former Sewer Outlets.*
   — Intercepting Sewers.



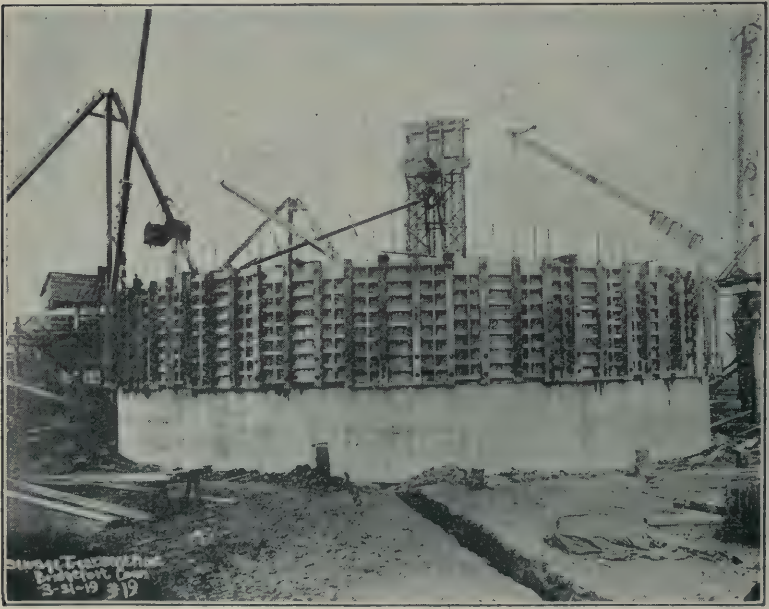
2. *Western Sewage Treatment and Pumping Station*



3. *Bridgeport Pumping Station. Forms in Place for First Ring*



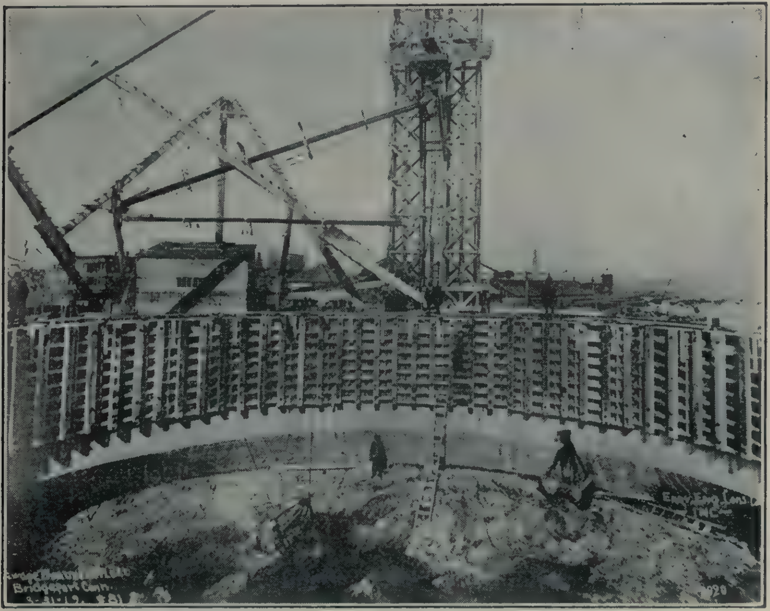
4. *Bridgeport Pumping Station. First Ring with Forms Removed, Showing Cutting Edge*



5. *Bridgeport Pumping Station. Forms in Place for Second Ring; Showing Concrete Distributing Tower and Derricks, Outside View*

Before going on with the work the firm of Hering and Gregory, successors to Hering and Fuller, were asked to review what had been done to date, and recommend a program for the future.

They made a thoro study of the problem and compared several arrangements of pumping stations and treatment plants, but finally decided in favor of the original Hering and Fuller plan, which divided the city into two districts, each one complete in itself. It was decided to complete the western district first, so contracts were let for the Railroad and Bostwick avenue sewer to the site of the pumping station at the foot of Bostwick avenue.



6. *Bridgeport Pumping Station. Forms in Place for Second Ring; Showing Concrete Distributing Tower and Derricks, Inside View*

Altho the city did not intend to build the treatment works at this time it was considered best to investigate sewage treatment methods in other cities and decide on the type of treatment which would be most suitable for Bridgeport. So a special committee inspected a number of sewage-treatment plants in near-by cities, including Brooklyn, Baltimore, Rochester, Worcester, Fitchburg and Plainfield. It was the opinion of this committee that the Riensch-Wurl fine-screen method of treatment was the most appropriate system for Bridgeport.

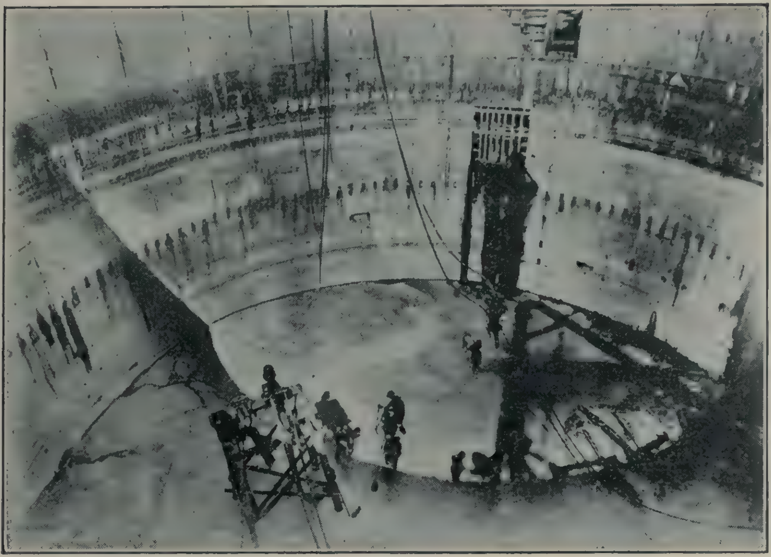
The only other method considered was the Imhoff, which was rejected mainly because of the uncertainty of the action of Imhoff tanks. It was noticed that many Imhoff-tank plants were unsatisfactory, altho designed according to the best principles, and that few of the plants which were operating satisfactorily were handling the amount of sewage for which they were designed.

A few years ago Bridgeport had a garbage-reduction plant within a few blocks of the site of the pumping station. It was so offensive, however, that it was finally moved to another location in a less thickly settled part of the city. As some of the Imhoff-tank plants that the committee inspected were much more offensive than our old garbage plant, it was thought best not to run the risk of repeating this experience on a larger scale with an Imhoff plant handling 35,000,000 gallons a day.

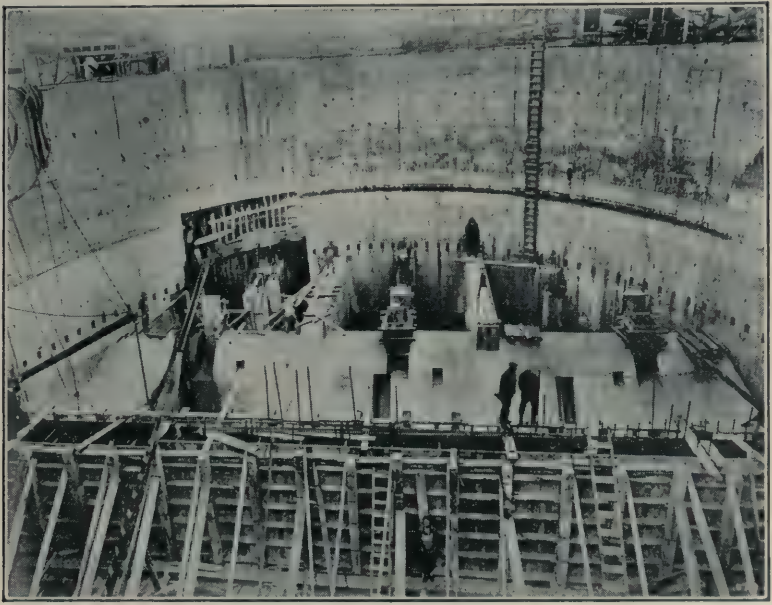
7. Bridgeport Pumping Station. Forms in Place for Third Ring

At the time of the committee's visit Plainfield was having an experience with their Imhoff plant, similar to Bridgeport's experience with the garbage plant; that is, it was a decided local nuisance. Since that time however, a Riensch-Wurl fine screen has been installed ahead of the tanks at Plainfield and the nuisance has been abated.

The special committee's report was submitted to two prominent sanitary engineers, George W. Fuller and George A. Johnson for



8. *Bridgeport Pumping Station. Showing Bottom (Put in Under Water) After Water Was Pumped Out*



9. *Bridgeport Pumping Station. Showing Some of the Inside Concrete Work*

their approval. They approved of the report, so plans were prepared for the western district pumping-station including screening equipment.

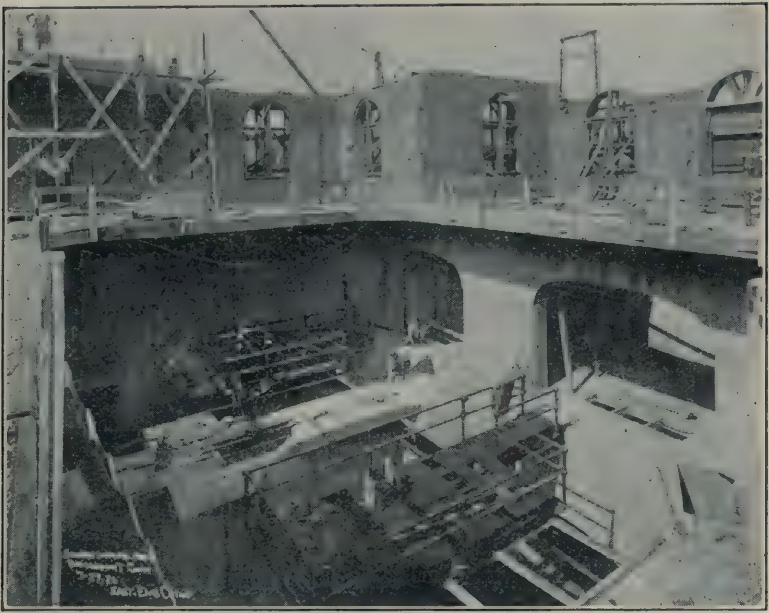
As stated above, when this investigation was started the city did not intend to build the treatment works at this time but simply to decide on the type of treatment plant which was most appropriate for this city. But in 1917 the State legislature passed a law giving the State Board of Health broader powers, and making it mandatory for that board to compel towns doing extensive sewerage work to treat their sewage. This made it necessary for Bridgeport to build a treatment plant as well as a pumping station. The Riensch-Wurl screen was well suited to meet this condition, for in the station as finally planned the screens and pumps are all in the same building, which is not much larger than the pumping station as originally planned.

The old Hering-and-Fuller report recommended disposal of Bridgeport's sewage by dilution. The process finally adopted was that of clarification by fine screens, followed by dilution. If further treatment is desired at some future time, the outfall can be extended, or if necessary additional treatment works can be built on land.

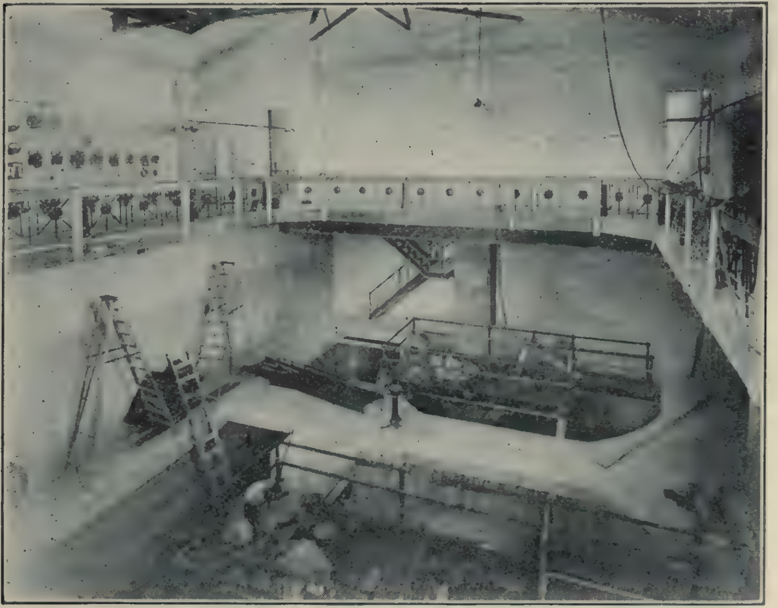
The flow line of the intercepter at the plant is at elevation 100, 22 feet below the street level and 10 feet below mean low water. Several combinations of screens and pumps were studied, including the plan of having high-level screens following the pumps, so that the screened effluent would flow by gravity to the outfall. This scheme would have saved something on the cost of construction of the station, but it was discarded mainly because the screens would be more effective if installed ahead of the pumps.

In the plant finally decided upon, the sewage from the 72-inch intercepter flows thru the sluice gate to a bar screen at elevation 100, thence thru a concrete channel to the Riensch-Wurl screens. The screened effluent flows over an adjustable weir to the sump at elevation 80 and is then lifted by the pumps to the force-main at elevation 105.

The plant is designed for 3 Riensch-Wurl screens, to handle a total dry-weather flow of 35,000,000 gallons per day. The estimated population of the district when fully developed is 180,000. As the present population of the district is in the neighborhood of 100,000, two screens will be installed now and the third one when needed in the future. The R-W screen consists of a circular disc 22 ft. in diameter inclined at an angle of 15 deg. to the horizontal. A truncated cone 12 ft. in diameter at the base is centrally mounted on the disc. The surface of both disc and cone consists of a number of removable bronze plates, perforated with slots 2 inches long and 3/64 of an inch wide. The lowest point of the disc is set at the elevation of the influent, and the slope is such that about 1/3 of the disc will be above the surface of the water.



10. *Bridgeport Pumping Station. Showing Screen Bridges and Motors*



11. *Bridgeport Pumping Station. View from Gallery Showing Center and North Screen Pits. Switch-Board on Left*

The sewage flows onto the screen, which is revolving at a rate of about one revolution in two minutes. The liquid passes thru the perforations in the disc and flows over the weir into the pump sump. The suspended solids which are retained on the screen are lifted out of the water as the screen revolves, and are brushed off the screen into the hopper of the screenings-conveyor system. The brushes are cylindrical and are carried on a revolving spider which is mounted on a shaft parallel with the main disc-shaft. These brushes work on the same principle as a street-sweeper, which is carried along the street mounted on a truck and at the same time is revolving and brushing the refuse ahead of it.

The screenings are conveyed from the hopper to the storage tanks by a pneumatic system, which does away with the necessity of handling it in open cans or on an open conveyor-belt. From the storage-tank, which is located 10 feet above the street level, the screenings will be dropped into tank-wagons, carted to the town farm and buried.

The pumping equipment consists of two 20-inch horizontal centrifugal pumps each having a capacity of 15,000,000 gallons per day, and two 15-in. horizontal centrifugal pumps with a capacity of 8,000,000 gallons per day each. These pumps are direct-connected to electric motors, controlled by floats in the pump-sump. The floats are adjustable and electrically connected to switches and automatic motor-starters, mounted on panels of the main switch-board.

A venturi tube is installed on the outfall, with the recording chart and register located on one of the main switch-board panels. The 60-in. gate-valve, electrically operated, is in a gate-house at the discharge end of the venturi tube.

The building, when completed, will contain a complete system of heating, ventilating and plumbing, including toilets and shower baths.

Early in 1918 the plans were approved by the State Board of Health and in August of that year the contract was let, subject to the approval of a bond-issue by the Federal Reserve Board. The bond-issue was finally approved so construction was started in January, 1919.

The substructure is a reinforced-concrete caisson 80 ft. inside diameter and 45 ft. deep. The cylindrical shell forming the outside wall is constructed of a series of rings 10 ft. high. The rings were cast above ground and after the concrete in each ring had properly set, the forms were removed and the ring was sunk until the top was approximately a foot above ground. The forms were then re-assembled and the next section was cast. When the caisson had reached the predetermined depth the bottom was placed under water. After the concrete bottom had set the caisson was unwatered, the bottom made tight and finished to a surface.

12. *Bridgeport Pumping and Screening Station. Riensch-Wurl Screen as Seen from Influent Channel*

13. *Bridgeport Screening and Pumping Station. Showing Screen and Cleaning Brushes*

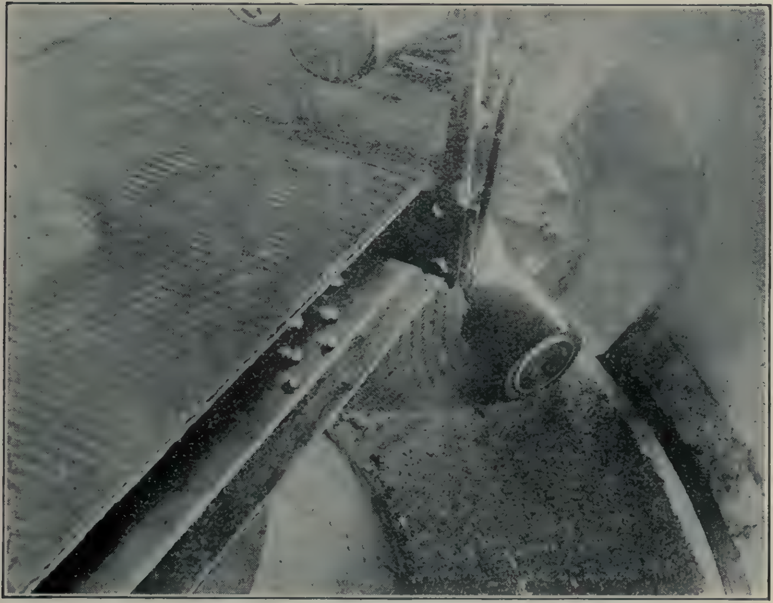
The lowest ring, which contained 475 cu. yd. of 1-2-4 concrete and 30 tons of steel was completed in March of last year, 1919. After a few days the forms were removed and set for the second ring. The same forms were used for all five rings. The second, third and fourth rings, each containing 500 cu. yd. of concrete and 16 tons of steel, were finished by June 1, the concrete being poured in continuous operations of about 8 hours for each ring.

After the first ring had been poured and the forms removed the ring was allowed to sink by excavating the material from the interior. Two ¾ yd. clam-shell buckets on two 65-ft.-boom stiff-leg derricks, set up on opposite sides of the caisson, averaged about 200 cu. yd. of excavation a day. One derrick was placed on the north side of the caisson, the other on the south. On the east side, towards Bostwick avenue, were two 1-yard mixers and an 80-ft. double hoisting tower from which the concrete could be delivered thru chutes to any part of the ring. Just north of the tower was another derrick which supplied gravel and sand to hoppers located above the mixers. As the excavation proceeded levels were taken at frequent intervals each day on the top of the shell and if one side was found to be sinking too fast, excavation was stopped on that side and continued near the other side until the ring was level again. At no time was the caisson more than 9 inches out of level. At first it was not intended to keep the caisson dry during excavation, but as the work proceeded and it was seen that there was not much water coming in, pumps were installed and the interior was kept dry during this part of the work.

Several of the engineers who looked over the job before the contract was let said it would be almost impossible to sink this caisson, as the skin friction on the outside would hold it up. As a matter of fact it went down so easily that the top ring was left off until the caisson was within 3 ft. of the bottom. Progress had been so satisfactory up to this point that an attempt was made to excavate still further and try to lay the bottom in the dry. It was found however that the pumps were drawing too much sand, which, flowing in from the outside under the bottom edge of the caisson, was undermining the derricks and concrete tower. So the top ring was put on, the caisson was allowed to fill with water, and the excavation was continued until the ring was down to the predetermined depth, and soundings showed that the excavation for the bottom was completed.

The bottom was then put in under water in one continuous operation. The same gang worked right thru and put in 1800 cu. yd. of concrete in 39 hours. The men were allowed to knock off occasionally for rest and refreshment, but the mixers were kept going continuously except when shut down for minor repairs. There was a 2-hour delay about noon of the first day, and the plant was shut down for about five hours at different times during the second day.

14. *Bridgeport Screening and Pumping Station. Rear View*



15. *Riensch-Wurl Screen at Plainfield*

The bottom was allowed to stand three weeks, then the water was pumped out. No leaks were found, so the floor was finished and work was commenced on the inside walls and partitions. The substructure is finished and practically all the pumping and screening equipment is installed. The rectangular superstructure, which is of tapestry brick with stone trimmings and a red tile roof, should be finished about the first of the year.

In the construction of the plant, which will cost about $900,000, we have used 12,000 bbl. of cement, 6500 cu. yd. of gravel, 3500 cu. yd. of sand, 210,000 bricks, and 110 tons of steel.

THE DISPOSAL OF TRADE WASTES

By Robert Spurr Weston, Consulting Engineer, Weston and Sampson, Boston, Mass.

It is not the purpose of the writer of this short paper to cover the whole field of the disposal of trade wastes, voluminous treatises on which have been written by such writers as Schiele, Wilson, Naylor and others. There are certain features of the subject, however, which are of particular interest to municipalities. These are the treatment of wastes which must be received into city sewers and disposed of by dilution or in disposal works after mixture with domestic sewage, all of which are apt to produce nuisances when disposed of within municipal limits.

Characteristics of Trade Wastes

Trade wastes differ greatly from sewages in their character and composition. Thus the sewage from the Center Avenue sewer at Chicago, receiving the stock-yard and Packingtown wastes, contains ten times as much total nitrogen, four times as much suspended solids, six times as much oxygen consumed, and nine times as much fats as the rather weak combined sewage from the Thirty-ninth Street sewers. Again, the sewages from Massachusetts and English industrial cities are totally different from those from residential cities in the same regions. The trade wastes are usually much more concentrated, yet ordinarily of smaller volume than sewages. Consequently their importance increases with the dominance of the industry producing them in each particular locality.

Trade wastes are important factors in the design and operation of sewage works because they may contain:

(1) Excessive amounts of suspended matter;

(2) Suspended matter which may clog sewers;

(3) Excessive amounts of fats and other organic matter;

(4) Waste mineral oil;

(5) Free acid;

(6) Chemicals which inhibit the purifying action of bacterial beds;

(7) Starchy or saccharine bodies which ferment with the production of butyric acid and other offensive compounds, and furthermore produce lactic and other acids which inhibit the action of the nitrifying bacteria.

It seems best in this paper to cite examples of the various classes of waste, altho it must be borne in mind that the members of each class may differ almost as much in degree, if not in kind, as the classes among themselves.

(1) EXCESSIVE SUSPENDED MATTER

In Peabody, Mass., not many years ago, wastes from rapidly growing tanneries, glue factories and similar industries were discharged into the North River and its tidal estuary between the cities of Salem and Beverly. At that time the stream conditions became unbearable. Sometimes the odor from the foul, dark-colored stream could be detected in Salem's best residential section, several blocks away; while at all times abundant bubbles of the gases of decomposition were generated in the putrefying deposits of sludge and rose to the surface of the stream. Conditions were by no means improved when a half-tide dam was constructed by the electric light company to insure a water supply for its condenser at all stages of the tide.

The condition in the stream was remedied by the construction by the cities of Peabody and Salem jointly, of an intercepting sewer discharging into a pump well, from which the sewage was pumped thru an outfall into deep tidal water. The various plants which had formerly discharged into the river were connected with the intercepting sewer. For a time all went well; but soon deposits accumulated in the sewer, particularly because pumping was often interrupted, and the velocity in the sewer was reduced to almost nothing. These accumulations of sediment are illustrative of the second class of difficulties, namely,

(2) THE SUSPENDED MATTER IN TRADE WASTES

This consists largely of spent lime, hair, strips of hide, particles of flesh, etc., which, when once allowed to settle in the sewer, compact into a pasty mass which can only be removed by scouring or mechanical cleaning.

To remedy this condition, the industries were required to submit their waste to subsidence before discharge into the sewer. The quantities of suspended matter in the wastes, however, were so large and the basins so often too small or neglected, that the difficulties, even at this writing have not been entirely overcome. A patented device, known as the Dorr clarifier, has helped to overcome the difficulty in two of the worst cases. This clarifier is a circular subsiding basin in which the waste enters at the center and is discharged at the circumference. The sludge which subsides to the bottom is moved constantly toward the center by means of plows attached to revolving radial arms. The sludge so moved to the center is pumped to a loading bin, which, in turn, discharges the thick pasty sludge into carts to be hauled away. The advantage of this device over hand-cleaned subsiding basins is greatest where large amounts of sludge are handled. It discharges sludge continuously, thus maintaining the efficiency of the basin for subsidence, and almost compels the proper removal and disposal of the sludge.

In addition to the subsiding basins, screens have been installed to remove the hair and hide from the waste before subsidence. These minimize the compacting of the sludge both in the subsiding basin and in the sewer, and greatly facilitate the removal of the sludge from either hand-cleaned or mechanically cleaned basins.

(3) EXCESSIVE AMOUNTS OF FAT AND ORGANIC MATTER

Wool-scouring waste, which is the soapy, alkaline liquor in which wool is washed prior to combing and spinning, is a good example of this class. The composition of wool waste depends very largely upon the character of the wool scoured. Wool from our own territories and from South Africa is often very dirty, while some domestic and most Australian wool is quite clean. The dirt consists chiefly of sheep manure and particles of soil over which sheep have grazed. It also contains other foreign matter such as fiber, burrs, etc. This waste is usually very concentrated. It may contain 3% of solids, of which one third may be fats. The fats are of two kinds,—first wool grease or lanolin, a waxy substance which is present in the raw wool, and second the fats combined with the soaps used for scouring.

The experience at Hudson, Mass., has illustrated the difficulties which this waste causes. Prior to 1909, the waste from a wool-scouring plant was discharged into the Assabet River. Complaints resulted in the discharge of the waste into the Town sewerage system, and its attempted disposal by septic tanks and intermittent sand beds. In a few months, the sand beds were completely clogged and had to be renewed, and the scouring-waste was again discharged into the river. Then complaints by parties below resulted in the construction by the company of an acid wool-grease-recovery plant. In this, the waste was treated in tanks with sulfuric acid or niter-cake, the whole being stirred with air. After the subsidence of the sludge the partially clarified acid liquor was discharged thru sand filters into the river. The effluent from this plant usually had an acidity of 2000 p.p.m., and contained less than 50 parts of fats. The sludge was discharged on sand beds, dried, made into burlap-wrapped "puddings" from which the grease was hot-pressed in steam-jacketed hydraulic presses.

However, the treatment of the waste with acid produced a local nuisance, due to the acrid odors given off from the acidified waste, and suits were brought by neighboring owners to recover damages. The company therefore determined to change its method of operation. Acid treatment was abandoned, and the heated and settled waste was passed thru centrifugal machines, and the effluent, after filtration thru the sand, was discharged into the stream. This process removes about 50% of the fats as compared with about 95% removed by the acid process, and it is questionable whether the discharge of the soapy effluent is desirable. The effluent possesses an advantage over the effluent from the acid process in that it is not acid, and while it contains more fats, they are either combined in the form of soap or are so thoroly emulsified that they are cared for by the stream without offense. The appearance of the stream at the point of discharge is not so good as when the acid waste was discharged.

During the war, the removal of fat was a very profitable process. With present prices, however, the cost of recovery per pound of grease is slightly greater than the selling price.

(4) PRESENCE OF MINERAL OIL

Increased use of fuel oil is placing an increased burden on sewage works. The large factories store large volumes of oil in tanks. In these, paraffine-like bodies settle out which, when discharged into the sewers at times of cleaning, coat their insides, and when conveyed to sewage disposal works cause a great deal of clogging. So far, examples of this effect are neither numerous nor as yet serious, but municipal officers are fearing more trouble on this account.

(5) FREE ACID

Certain sewerage systems receive the drainage from mines; others receive the so-called "pickling liquor" from plants where steel plates or wire are scaled by immersion in sulfuric acid. This factor is most important in cities like those in the Pittsburg region where there are large steel wire and plate mills. At Worcester, Mass., acid waste is discharged at certain times of the day, and is stored in tanks so that it may be distributed uniformly thruout the twenty-four hours and thus be neutralized by the rest of the sewage.

Recently a patented process has been used to treat acid wastes of this kind. Lime or powdered limestone is added to the waste, and the precipitate is recovered in a continuous subsiding basin of the Dorr type. The sludge so produced is recovered and used for the purification of illuminating gas.

(6) PRESENCE OF BACTERIAL POISONS

The wastes from many tanneries where arsenic is used, and sewages containing free chlorine and copper salts may not be purified by bacterial action. The sewage of the East Street sewer at New Haven is an example of this, as are also the sewages of many other Connecticut cities largely engaged in the manufacture of brass and copper articles. At New Haven, Professor C.-E. A. Winslow, in a long series of experiments, determined that this sewage could not be purified by the activated-sludge process because of the poisonous action of the copper salts contained in the sewage, and recommended that the waste be acidified with sulfurous acid and the sludge produced by this treatment be dried and degreased to recover fats and fertilizers, following the methods recommended by Hatton for the utilization of sludge at Milwaukee. The process is known as the Miles process and has been described before this Society.

(7) THE PRESENCE OF ACIDS RESULTING FROM THE FORMATION OF CARBOHYDRATES

In the manufacture of lactic acid from starch, and in the manufacture of sugar, whether from beets or from cane, there is produced a waste which ferments quickly and rapidly with the production of lactic acid, also small quantities of butyric and other foul-smelling compounds. Similar decompositions take place in the waste whey (containing sugar), discharged from cheese factories, when an attempt is made to dispose of wastes containing it by subsidence. They ferment rapidly until enough lactic acid has been produced to stop fermentation. The addition of lime causes fermentation to begin anew, but the calcium lactate formed by the addition of lime also decomposes with the production of butyric acid and other disagreeable compounds. Further decomposition in the presence of sulfates causes the evolution of hydrogen sulfide.

An attempt by the writer to dispose of this waste by treatment in tanks and on trickling filters has not proved successful. Pearse and Greeley, in experiments with the waste from beet-sugar factories, have shown that successive treatments with lime, each treatment followed by filtration, will produce effluents suitable for discharge into most streams. How to purify it for discharge into the beds in the dry season, a crying need in Cuba, is a question that has not yet been answered. The best solution which has been offered is to remove the saccharine bodies by an alcoholic fermentation, using yeast, and to dispose of the waste so treated by subsequent subsidence and filtration, with or without the addition of lime as may be necessary.

It is as a local nuisance that the problem is of interest to municipal officers. At Mansfield, Mass., a lactic-acid factory was established near the residential section of the town. The solid portions of the waste were discharged upon filter beds, the effluent from which was in a putrefying condition. The liquid portions were discharged into a swamp in which they created an intolerable nuisance, killing vegetation, and producing deposits of black sludge, smelling strongly of hydrogen sulfide and rancid butter. No solution of this problem was ever worked out, for the company gave up business while a suit by the Town against them was pending.

The citation of the above cases is enough, the writer believes, to give an idea that trade wastes show far greater variation in character and kind than do ordinary sewages, and each waste is a problem by itself. Municipal officers, therefore, in designing sewerage systems, should carefully consider the industries which the system is to serve; and where new industries are projected, the character of the business should be carefully determined with respect to its effect upon the sewage and particularly the sewage-disposal system, if such there be.

Since the days of Herbert Spencer, scientists and economists have deplored the loss of values by the discharge of the wastes of human life and industry. While the word conservation has a taking sound, and there is great opportunity for its employment in the industries, opportunities for disposing of water-borne wastes at a profit are few. During the war, wool grease could be recovered at a profit; and some recent studies here and abroad promise the profitable recovery of grease and fertilizer base from certain wastes and sewages. But on the whole, the recovery of valuable products from water-borne waste cannot hope to be a profitable business. On the other hand, it can in many cases minimize the cost of disposal and at the same time conserve valuable by-products.

In the eastern part of the United States, the necessity for studying the trade-waste problem is increasingly pressing. This study was neglected during the war, altho the war industries polluted many streams as they were never polluted before. The conditions of rivers like the Blackstone, the Passaic and other smaller rivers are largely due to the discharge of trade wastes, and in many places the removal of these wastes is demanded. In some cases they must be discharged into the municipal sewerage systems; in others, separate disposal by the industries must be insisted upon. In any case, each problem is like no other, and must be studied in the light of its own surroundings.

DISCUSSION

L. L. TRIBUS (by letter)—The text is "Trade Wastes and Their Disposal." Having made that statement, the writer may perhaps be pardoned for not largely discussing the theme, and for digressing to certain other phases of municipal refuse handling.

The collection of so-called trade wastes is one of the moot points in municipal economy.

We do not ask the public to deliver our groceries, meat and vegetables, our furniture, utensils or clothing, but expect to pay for such service in the store-keeper's charge; which also includes his costs of receiving materials in bulk. Just as soon, however, as we use the supplies, and break the furniture, wear out the utensils, and generally get thru with things, we expect the public at large to pay for removal of the discard.

Usually this is done for the householder, without objection, but just as soon as the unit quantities increase and the store-keeper asks that his rejections be removed, it becomes trade waste and its removal must be a special cost or charge.

Where is the dividing line? Let that discussion remain in Mr. Weston's paper and the text, while the following notes are directed to other points of the great subject.

Current events are fast crowding the Great World War into past history, tho the perspective of the future will cause it to again loom into tremendous importance, as its influence will be recognized in every phase of living.

The point of special import for these notes, however, is its effect upon garbage disposal, and official consideration of the subject.

City officials, as a class, have not wakened to its importance. Engineers, who have been occasionally retained to report, have not been paid sufficient fees, or given time and aid, to do the business justice; consequently the large majority of reports are a jumble of statistics gathered from data of other cities; a study of the special city's growth, past and prospective; some estimates of costs by different treatment processes, and references to other matters of exceeding importance, but necessarily passed over, thru lack of time (and actually lack of money). Not infrequently clever representatives of "process" companies glowingly paint the benefits of their furnaces or kettles; the city officials fall for the scheme, and chuckle how they saved an engineer's fee.

Occasionally a conscientious man makes a really intelligent and worth-while report, with recommendations that would result in municipal economy and efficiency, if carried out, but the elected or appointed Solons are afraid lest they become unpopular and some jobs be lost to their camp followers, or nice little perquisites become matters of memory to their political backers, or perchance the city cannot stand the cost of suitable equipment, even tho its establishment would result in large later savings.

Practically every city treats the subject of refuse in three phases: (a) Health Department Ordinances, which designate the nature of offensive or unsanitary wastes and name requirements for their care and disposal as to receptacle, vehicle, etc.; (b) Wastes Department—municipal collection of refuse, or part supervision over private collectors; and (c) Treatment Works and Final Disposition.

As private interests have seen profit in the last feature, that has been virtually the only one specially exploited, and the costs or economies possible in the prior stages have been virtually neglected.

In a large city there is great variation in character and quantity of wastes in different districts; different conditions of occupancy and varying collection problems, hence the possible propriety of adopting several different final treatment methods.

But no, like the 5-cent street-car fare, one method must prevail thruout, regardless of suitability, and the engineer's advice weighs too little in the final decision.

For sizable cities, reduction, incineration and hog feeding have been the recent prime methods, barring New York which, tho possessing several small incinerators of different types, after attempting to make huge reduction plants serve under private operation, has gone back again to ocean disposal as its wasteful and costly chief method, hoping, however, to make the plan only temporary.

A committee of New York officials and engineers of several departments which have nothing to do with garbage problems, is now studying the question. It hopes, thru public hearings, voluntary testimony, gathered reports, etc. to finally prepare a report that will enable the present administration, in its remaining year and one-quarter, to solve the problem.

The vital defect in almost every instance of official action is the lack of appreciation that it actually involves every step from the householder's receptacles, and nature of contents, thru collection, transportation, and treatment, and the ultimate disposal of the resulting valuable by-products and residual waste.

San Francisco, Chicago, Columbus, Cleveland, Milwaukee and Savannah have furnished the basis for many reviews. The pioneer calorific tests in the Boro of Richmond (City of New York) have given data of value. For a really comprehensive, intelligent and complete expert study, however, in a large city, the record is still almost clear.

But to our bacon:—the war demanded food, powder, and conservation of wastes.

Porkers furnished a good kind of food. Grease was essential to soap and nitroglycerine. The saving of municipal rejections looked like good patriotic policy.

Most incineration plants in this country have been but half used; their surplus products of heat and slag go largely to waste so that, admitted to represent the most sanitary method, they are charged with extravagantly destroying much of value.

The average reduction plant has not produced the grease and fertilizer base in such quantity and of such quality, to say nothing of the nuisance and expense usually attending the processes, as to make the method appeal to any but the patriotic and the possible operator.

Hogs, however, with their grunts of satisfaction over good meals of fresh, half-rotted and wholly rotten garbage, did so appeal, particularly to those living some distance from the farms, say in Washington, for instance.

As with the geese of France, gorged with food and kept from exercise, to make of their enlarged livers the prized pate-de-foisgras, so the hogs in restricted quarters developed into astonishing food-consuming machines, with rapid development of ham, bacon and fat, so much in demand.

It is scarcely to be wondered at that popularity met hog feeding, particularly as high prices rewarded the owners, and the public generally continued to pay the bill for collecting and transporting the garbage.

In some instances the public has secured some return, thru favorable contracts, and has escaped the expense for mechanical plant operation, in exchange for a simple method.

Long-time advocates of hog-feeding certainly came into their own, with such extensive adoption of the system as has taken place; Buffalo and Baltimore being conspicuous examples.

If the municipality gets the return, well and good, provided the collection costs are not enough greater to offset the profit, but how rarely do the taxpayers get other than the short end of the bargain.

Municipal wastes in the aggregate, including garbage, possess value, which should be recovered and potentially yield a return, offsetting in part their gathering.

Mechanical and chemical plants can be designed, be built and be operated, so as to produce valuable by-products, without creating local nuisance, provided fresh materials are utilized, and good brains conduct their operation.

Fresh materials mean frequent collection and short haul. Profit-securing requires honest and skilled operation, with "free market" for sale of recoveries.

Hog-feeding as an outcome of the war has in large measure come to stay, but when officials can be persuaded to have complete studies made by men versed in the subject, and then have the courage to put suitable methods into use, the taxpayers will get service at its economical worth.

Hog-feeding will thereafter pass largely into history, for hog food itself is but one element of the city's rejections. Rubbish, ashes and trade wastes are all inseparable items of the great united problem—of collection, treatment and disposal of the city's wastes.

THE MILES-ACID PROCESS ON TANNERY SEWAGE WASTE

By E. S. Dorr, Engineer Sewer Service, Boston, Mass.

In June 1916, a sample of tannery waste was submitted to the Miles-acid process. The sample was very high-colored and was heavily charged with organic and mineral matter, 6,449 p.p.m., of which 4,866 were mineral and 1,583 organic and volatile. Upon the application of sulfur dioxide the waste cleared in about five minutes and was well settled in half an hour. The dark blackish-red color was bleached to straw-color, the SO_2 used was at the rate of 860 p.p.m. (7167 lb. per m.g.). Probably 900 p.p.m. (7500 lb. per m.g.) would be advisable to secure sterility. Bacterial reduction was not noted.

The odor was completely killed.

The reduction in the organic and volatile matter, including suspended solids, was 50%.

The precipitated sludge was at the rate of about 4 tons (dry) per million gallons with a grease content of 16.88% and ammonia content of 7.50% in the undegreased and 9% in the degreased sludge. In pounds the amounts are 6,640 lb. degreased sludge, or fertilizer material, and 1,360 lb. grease.

The fertilizer with 9% ammonia at $7.50 per unit (present value tankage Aug. 1920) would be worth $67.50 per ton, or 3.3 tons would be $222.75 per million gallons.

The grease at the prices assumed in the New Haven investigation (and tannery grease is probably worth more) would be worth at 5 cents per pound $68.00 and at 8 cents per pound $108.80 per million gallons. So that the total value of grease and fertilizer would run from $290.75 to $331.55 per million gallons treated, according to the quality of the grease. (The free fatty acids were 48%, percentage of unsaponifiable was not determined.)

On the other hand the cost of operation would be high. About five times as much acid would be required, and twenty times as much sludge per million gallons, would have to be handled as at the Boulevard Sewer in New Haven. The cost of operation at that outlet was reckoned at $20.98 per million gallons, of which $10.74 was for acidification. As the flow was not large, about 6,000,000 gallons per day, the New Haven figures may be taken as a basis for estimating the probable cost of handling tannery waste. Correcting in the ratios indicated above, for the heavier tannery waste, the cost per million gallons would be $161.22.

The value of the products has been figured above at from $291.00 to $331.00 per million gallons treated. This estimate therefore shows a surplus of values over costs of $130.00 to $170.00 per million gallons.

In view of the fact that, so far as the writer is aware, no revenue has been obtained from tannery wastes, but, on the contrary, they are a source of expense for disposal, it would seem that this process is worthy of the attention of tanners. In addition the facts that the sludge and effluent are inodorous, that the color is so bleached that with reasonable dilution it would not be noticeable except close to the outlet, and that the effluent is sterile or can be made so by the addition of acid (for the cost of which there is ample margin between values and costs), should still further commend it to attention and experiment.

REPORT OF COMMITTEE ON STREET LIGHTING

Your Committee in reporting the present trend of street lighting wish to add the following to what has already been set up in their last annual report:

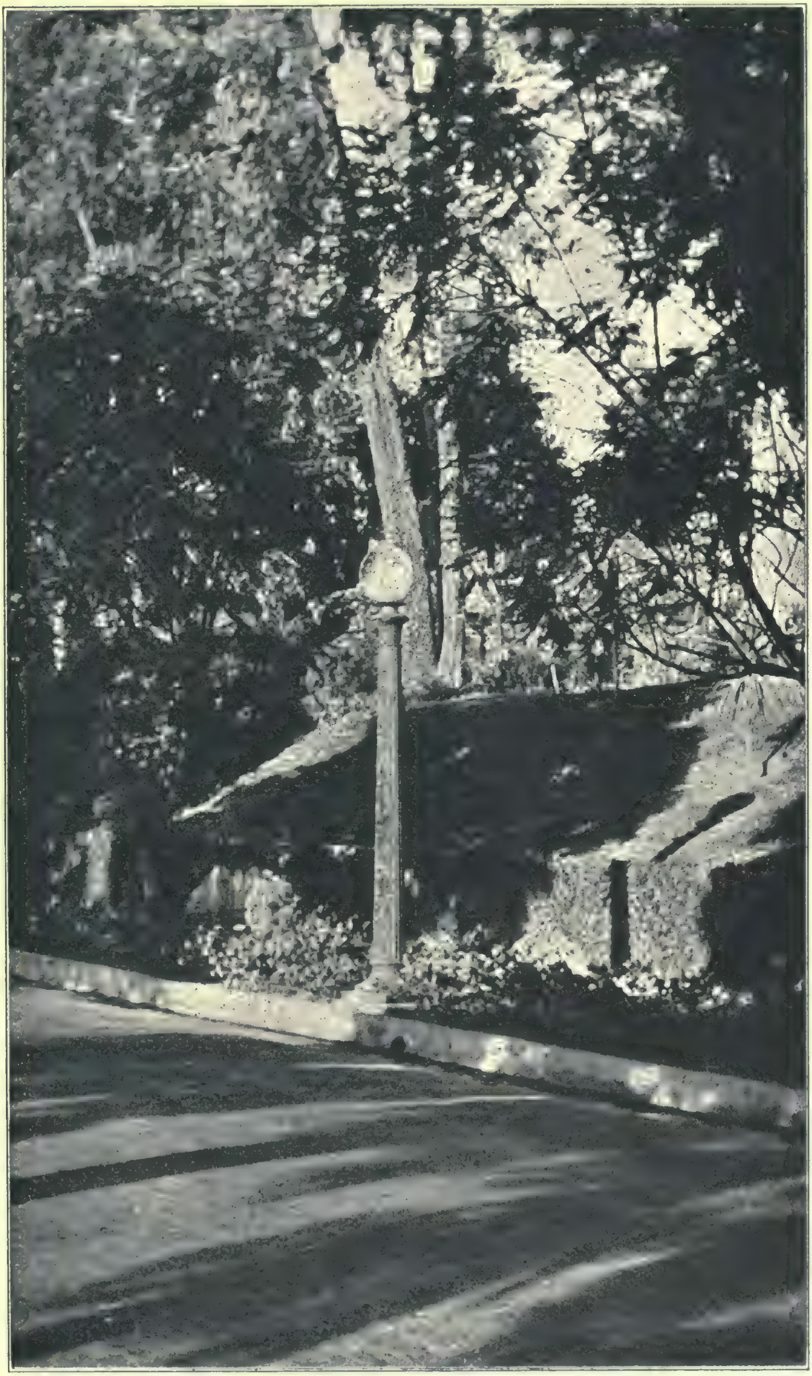
The trend in street lighting and illumination has been practically the same as that covered in the last report with the exception that there is a tendency in the larger cities to instal on the principal thorofare, or thorofares, usually the main thorofare of the city, what is known as high-power lamps, either the gas-filled, or, in exceptional cases, the luminous arc.

New installations have just been made on Broadway in the city of Los Angeles, at Saratoga Springs, N. Y., at New Orleans and at San Francisco. These installations are composed of ornamental iron poles carrying one or more lamps at the top. Considerable height has been added to the poles, in some cases 27 feet, in contrast with lower candle-power units installed heretofore.

There is a tendency to substitute for residential lighting a lantern neatly designed to replace the round globe which has been so extensively used heretofore. There is an advantage in the lantern in that when a glass becomes broken it is not as expensive as the replacement of the globe. As an illustration; an 8 x 18 globe costs at this time approximately $7.50, the 8 x 16 nearly $5.00. Therefore it is easily seen that the replacement of one or two panels in a lantern is much less expensive and, furthermore, the lantern is a change and when of proper design is very artistic.

Greater effort is being put forth in designing street-lighting systems artistically. This refers to the standards as well as the lamp equipment. In former years our street-lighting systems were anything but artistic, and some of them very cumbersome and unsightly. These are all giving way to the more modern, artistically designed equipment.

Practically all street lighting heretofore has been on the series system. There is a tendency, however, to instal multiple systems. The thing that stands in the way of the increased use of the multiple system is the problem of controling the system, i.e., turning the lights on and off in a way that will not only be economical but dependable. The constant-potential multiple system with proper control offers considerable advantage over the old constant-current series system. It has greater flexibility



1. *Type of Ornamental Street Lighting*

in the number of lamps, the elimination of station apparatus, taking advantage of the use of constant-potential transformers already in service for commercial purposes, power factor practically unity. It seems that the tendency will be for an increased extension of constant-potential multiple systems except where special systems are required for white-way lighting.

The practice on the part of municipal officials today is to spend more money for street illumination. In this connection often comparison as to the cost of street lighting on the per capita basis is made, but it does not tell the whole story. The true comparison is the number of watts per mile of street or the candle-power per mile of street. Then too, the rate paid for electrical energy must be taken into consideration.

2. *Pasadena Street Lighting*

The tendency in the past has been to illuminate one downtown street, or the business section, and leave the residential section unprotected. There is a clamor for electric street illumination to replace the inadequate gas-lighting of the past age. Changes are being made as fast as the old contracts expire. It is difficult for gas illumination to compete with first-class electric street illumination.

In changing over street-lighting systems from gas to electric, in many cases the old iron lamp-post can be used by substituting a neat and artistic top-casting carrying the necessary socket, receptacles and glassware. This will save considerable expense in the installation of an ornamental street-lighting system in a residential section in the replacement of gas lighting. This has been done in Chicago with good effect.

More money is being appropriated for street lighting than in the past because of the fact that it is now realized that a well-lighted thorofare is a great aid to the protection of the inhabitants of our cities, a great aid to the police department and fire department and furthermore, greatly adds to the safety in these days of the advanced use of motor-propelled vehicles. As an illustration we might use the Summary of Cleveland Traffic-Accident Survey as put out by the National Lamp Works, illustrating the need for well-lighted streets for aid in the avoidance or in the lessening of accidents.

SUMMARY OF CLEVELAND TRAFFIC-ACCIDENT SURVEY

A survey was recently made in the city of Cleveland of the 3549 traffic accidents shown on the records of the Police Department for a period of one year.

The purpose of this survey was to determine, if possible, how many of the 1059 accidents which occurred after dark would have been avoided had daylight or its equivalent been available. The simplest way of arriving at such a determination would be to compare the accidents which occur between, say, 5 to 9 p.m. in mid-summer when daylight is available, with the number for corresponding hours in mid-winter when it is dark. The excess of winter accidents between these hours over the corresponding number in summer might then be taken as a measure of the proportion of the total of 1059 night accidents which are attributable to lack of light. The records for Cleveland actually show that there were 157 accidents between these hours in June and July, while for December and January the total was 193. These figures do not show the true relation, however, for there are several other variables besides the question of daylight and darkness which one must take into consideration when comparing accidents in winter with those in summer. For example, there are as a rule very many less vehicles on the streets in mid-winter, hence less liability of accident; on the other hand, this factor is counterbalanced to some extent by the effect of slippery pavements. It is necessary, therefore, to separate out these other variables before we can decide upon just how many of the winter accidents should be attributed to lack of light. Obviously, we can find the relative effect of all these other factors except lighting by comparing the number of accidents which occur during the middle of the day in winter months with those in the summer months, or, for that matter, those that occur in the middle of the night at both seasons of the year.

On this point the records show for December and January 12½ per cent less accidents between 9 a.m. and 4 p.m. than occurred during the same hours for June and July, and they also show 8½ per cent less accidents for the winter months during the hours that were dark at both seasons, viz., from 10 p.m. to 5 a.m. We are justified, therefore, in stating that except for the question of light there would really have been fewer accidents between 5 and 9 p.m. in the winter months than for the corresponding summer months. To be exact, instead of 193 accidents in the winter for every 157 accidents in the summer, we would have found 140 accidents in the winter had it not been for the lack of daylight. In other words, there were 53 accidents which can be attributed directly to lack of light. If we apply the same proportion, viz., the ratio between 53 and 193 to the total number of accidents occurring after dark in Cleveland during the whole year, 1059, we find that 292 of them are to be attributed to lack of light, and of these at least 14 must be classed as fatal accidents.

3. *Pasadena Street Lighting*

AN ANALYSIS OF THE 3549 YEARLY ACCIDENTS IN THE CITY OF CLEVELAND.

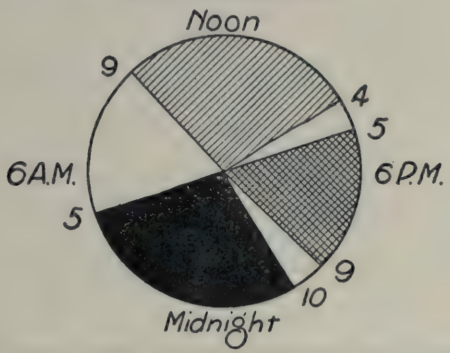
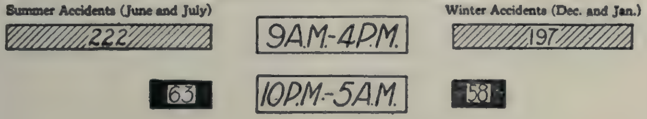
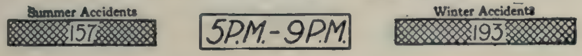


CHART I



The net result of better conditions of pavement on the one hand, and of greater density of traffic on the other, is a 10-12 per cent decrease in accidents during the winter months. This condition obtains whether the record is taken for the daylight or the totally dark hours.

CHART II



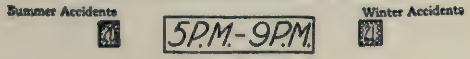
During four hours of the evening which have daylight in the summer but are dark in winter, the number of accidents in winter over the whole city is 23 per cent more than in summer.

From Chart I, a 10 per cent decrease would have been anticipated. In other words, the lack of light is the cause of 38 per cent of the accidents which occur after nightfall.

There were 1059 accidents which occurred after dark last year.

CHART III

White Way District



The record for the well-lighted section of the City indicates no material increase in winter over summer accidents throughout the evening hours.

The question of street-lighting contracts is constantly coming up. From experience it is apparent that valuation of street-lighting equipment should be taken and the rates for street-lighting based on the real cost of supplying electrical energy for street-lighting purposes.

In 1915 the Legislature of Wisconsin passed an act known as Chapter 490, which provides that municipalities, except cities of the first class, may grant the right to build and operate for electric lighting to a corporation and at the same time contract with it for service for an indeterminate term, provided that the prices are subject to an adjustment at periods not exceeding five years, taxes to be especially levied for this purpose, notwithstanding any limitations to taxes or expenditures for this purpose which may exist in the charter of the municipality. It is stated that this law provides a method that will settle many difficult street-lighting problems thru a contract for an indeterminate period with payments based upon cost of service.

The valuation of the physical property of the electric utility used exclusively for street-lighting purposes is made and also the valuation of that property used jointly for street-lighting and commercial or other service is also made. In this way the true valuation of all physical property for supplying electric energy for street-lighting is set up, the interest and depreciation charges are added, the cost of operation, maintenance, etc., is included, giving the exact cost of electrical energy for street lighting.

C. W. KOINER, *Chairman*
THOS. J. WASSER
WM. F. SCHWARTZ

REPORT OF COMMITTEE ON PARKS AND PARKWAYS

The specific duty of this Committee under the rules is to prepare a report upon the general progress made during the year in the art of designing, constructing and maintaining parks and parkways as located upon the city plan, including shade-tree strips and vegetation generally along city streets, and to secure papers for the annual meeting.

When this year's committee began to familiarize itself with its work, it found that previous committees had not in general attempted any review of the progress in the art. We have concluded that they found the task laid down by the literal reading of the instructions was too great to be attempted by busy men within the short tenure of their committeeship. Moreover, to measure progress, we should have some starting point, and your Committee endeavored to consider how this might be obtained.

We believed that the first step should be to determine what subjects are included under the term "Parks and Parkways," and we have adapted to this purpose a classification, based upon the "Analysis of City Planning for Classification of Books, etc.," by James Sturgis Pray and Theodora Kimball, which is as follows:

- Channels of Transportation.
  - Thorofares.
    - For Pleasure Traffic; Drives.
      - Formal Boulevards.
      - Informal Parkways.
      - Concourses.
      - Bridle Paths.
      - Bicycle Paths.
  - Footways.
    - Walks and Paths.
    - Promenades, Malls, etc.
  - Street Planting.
- Open Spaces, Public and Quasi-public, Other than for Traffic.
  - Parks and Reservations.
    - Reservations.
      - Forest Reservations.
      - Shore—Recreational Waterfronts.
        - Seashore.
        - Lake.
        - River.
        - Island.
      - Reservoir Reservations.
      - Summit Reservations, Outlooks, etc.

        - Places Containing Special Natural Features.
        - Places of Historic Interest.
    - Large Parks—County Parks.
    - Small Parks, Commons, Garden Squares, Neighborhood Parks.
    - Public Gardens.
        - Botanical Gardens.
        - Zoological Parks.
        - Others.
    - Open Air Theatres—Settings for pageants.
    - Open Air Concert and Beer Gardens.
    - Amusement Parks—Street Railway Parks.

- Play Grounds and Athletic Fields.
    - Playgrounds.
        - Shelter Buildings.
        - Swimming and Wading Pools.
        - Apparatus.
        - Planting.
    - Athletic Fields, Ball Grounds.
        - Stadiums.
    - Race Tracks, Speedways.
    - Aviation grounds, Aerodrome.

- Drill Grounds.

- Squares.
    - Station Places.
    - Market Places.
    - Congregating places, fora, exchange places.
    - Architectural, Monumental.

- Cemeteries.

- Open Spaces Devoted to Operation of Special Municipal Services.
    - Water Supply areas.
    - Sewage Disposal areas.
    - Municipal Dumps.
    - Yards, stables for use of municipal departments, City Yards, Areas for Storage of Municipal Equipment.
    - Municipal Nurseries, Greenhouses.
    - Other.

- Grounds of Building Groups.
    - Civic Centers.
    - Architectural and Monumental Squares.
    - Exposition Grounds.

Grounds of Single Buildings.

Legal Conditions Affecting Open Spaces, etc.

Administrative Conditions.

Economic and Financial Conditions.

The number and variety of the subjects given above is sufficient explanation for the failure of previous committees to attempt a review of progress in the art. Moreover, considering the membership and objects of this society, it is our opinion that a broad consideration of the elements of design is all that is necessary, leaving the consideration of details to those who specialize in the subject.

We believe that methods of construction are so largely influenced by local conditions that they would not prove of general interest to the society. However, novel methods of construction should be given full treatment in papers describing individual park systems.

We desire to emphasize the necessity of comprehensive planning of all features of a park system to secure a harmonious and consistent development, and as this will be a matter of only occasional occurrence, it does not lend itself to a yearly record of progress. However, the task of maintaining a park system is ever present with the municipal officials and engineers and it seems to us that the Society might well sponsor a uniform system of reports giving physical and financial data in such a manner as to facilitate comparisons and aid in securing efficiency.

A number of such reports covering a series of years would be a good foundation for further efforts on the part of the Society at standardization and afford a start from which to record progress.

Any comprehensive consideration of the bases of design of a park system will at once bring out the interdependence of parks, playgrounds, main lines of communication, transportation, density and distribution of population, zoning, land subdivision and the other elements which are now grouped under the term of city planning.

There is a growing appreciation and active interest in the subject of city planning and we feel that this Society should recognize this tendency of the times and provide for the co-ordination of the activities of the various committees which now consider various phases of the subject.

Summarizing the above your committee recommends:

1. That the Committee on City Planning be enlarged to 15 members and that five sub-committees be appointed to consider

1. Transportation and Communication.
2. Other Utilities.
3. Land Subdivision.
4. Zoning and Districting.

5. Parks, Recreation Facilities and Public Buildings and Grounds.

It is recommended that the chairmen of the sub-committees form a committee on "Coordination" to direct the activities of the sub-committees.

2. That the sub-committee on Parks adopt a program of subjects to be studied and devote a year to each.

3. That this sub-committee be authorized to confer with other associations, agencies and individuals interested in the subject in order to secure as representative a conclusion as possible.

4. That the first work of this sub-committee be the establishment of a uniform method of reporting the physical and financial statistics on park systems.

5. That this sub-committee consider the advisability of co-operation with other agencies in the preparation of a bibliography on the subject assigned to it for study and report.

6. That the committee on Parks and Parkways be discontinued.

JOHN M. RICE, *Chairman*
F. L. OLMSTED
THOMAS ADAMS

THE MAKING OF REGIONAL SURVEYS

By Thomas Adams, Town Planning Adviser, Ottawa, Ont.

At the last meeting of the American Society for Municipal Improvements I had the honour to submit a paper dealing with some of the general principles underlying the planning of industrial regions. Among other things I endeavoured to show that the ordinary municipal area comprised within the boundary of a city, town or village could not be properly planned without consideration being given to the problems of the industrial or agricultural regions of which these cities and towns were a part. Large cities to-day are overflowing their boundaries and are surrounded by satellite towns and scattered suburbs outside their areas. The regions in which these cities and their satellite communities are situated, have, in addition to the local problems of each separate municipal unit within the region, a number of important problems which can only be effectively studied and dealt with as regional and not as city or town problems. That is particularly true of the location of industries, the planning of main roads and railroad arteries, and the designing of park and sewer systems. Such areas as the Metropolitan region of Boston; the manufacturing district comprised in Philadelphia and the adjacent incorporated areas along the Delaware river; the districts which may be described as Greater Chicago, Greater Pittsburg and Greater St. Louis are typical of large industrial regions which can only be properly planned by co-operation between a number of local councils. Altho there are great difficulties to be overcome in securing this kind of co-operation, there are cases such as in the Border City area in Ontario, opposite Detroit, referred to in my previous paper, where effect is being given to a practical scheme of co-operation between five councils.

In agricultural territory there are also valleys like the Boise Valley in Idaho where there are a number of towns scattered thruout a fertile farming region which need to be planned as a whole. The development of the separate communities in the Boise Valley largely depends on the development of the system of transportation by rail and road, and the utilization of water for power and irrigation for the whole valley.

In territory where there are mining operations the need of the regional plan is perhaps most evident because of the specially scattered nature of such operations resulting in the growth of a series of small towns or villages around the pit-heads with probably one or two main commercial or business centres in the neighbourhood. This class of areas probably requires the regional survey and plan to a greater degree than any other kind of industrial area. For instance, in the mining region of Nova Scotia there are several towns comprising Sydney, North Sydney, Sydney

Mines, Glace Bay and a number of smaller satellites which have all grown up around the coal mines and are all connected with the main industry of coal mining and such subsidiary industries as that of steel making. These towns really comprise one industrial community scattered over a wide region, interspersed with large areas of farming and timber land and divided into a number of municipal areas or units for purposes of local government.

SOME REGIONAL PROBLEMS

Within all these regions, manufacturing, agricultural and mining, there are the following problems that need regional consideration and treatment:—

1. Control of overflow of population from main center following industrial expansion along railroads and rivers, or taking the form of new residential suburbs.

2. Design and development of main arterial system of roads radiating from central districts to adjacent towns and rural areas or forming connecting highways between the radiating highways, and coming under the jurisdiction of several municipal councils.

3. Planning extension of railroad and other transportation facilities, their terminals and stations in relation to the growth of industries and population and the topographical conditions of the region.

4. Planning and acquisition of parks and parkways so as to form a comprehensive system for the complete industrial district.

5. Making the zoning plan to control height, use and lot-occupancy effective over a wide-enough area so as to prevent bad beginnings of development in the unbuilt suburbs and to secure that the progressive action of one municipal council will not be made ineffective by the lack of control outside its boundaries.

6. Planning of comprehensive sewerage treatment, water-supply and power developments where topographical or industrial conditions make united action of adjacent municipal councils desirable or even necessary for economy and efficiency.

PRACTICAL DIFFICULTIES OF REGIONAL PLANNING

The suggestion that a general regional plan of an industrial area should be prepared is open to criticism on two grounds. First the difficulties to be confronted in getting united action by adjacent and often jealous local councils within a region are considered so great as to make it hardly worth the effort to promote regional planning. In theory this is plausible but, in practice it will be found that not more than the preliminary administrative difficulties in most cases, will be met. Secondly even when these difficulties are overcome and co-operative action is secured between several councils the legal difficulties of meeting the cost of a general scheme by a joint board are likely to be almost insurmountable.

In the Border Cities' area both these difficulties are being overcome by the creation of a statutory body called the Border Cities Utilities Commission representative of the several municipalities and having powers given by statute to raise money for its operations. The best it can do, however, is to prepare a general skeleton plan dealing with the problems that affect all the five municipal districts in common, leaving the detailed planning and its execution to be dealt with later by each municipal council in respect of its own area. Indeed this is all that can be accomplished by a regional commission. Its function is not to do any planning that can be as well done by the local council but merely to prepare the skeleton plan of the region as the basis for the plan of each city, town, village, or rural municipality within the regional area.

The Regional Survey

All planning whether of region, city or other area should be preceded by a survey. This survey should have as its object the presentation in graphic form of the topographical features and structural development of the area. No proper plan can be prepared as a guide for future development until a map or series of maps are prepared after a survey showing the existing development and, in the case of uneven country, the levels of the land.

Whether or not a regional plan is considered practicable in an industrial district, a regional survey should be prepared. Joint action of several adjacent councils in the matter of preparing a regional survey is less difficult than that of preparing and executing a regional plan. In making the survey no action is contemplated that would interfere with the local jurisdiction of the municipal councils, or that would impose on them any restrictions on development, as might be the case with a regional plan. A survey does not introduce any element that requires legal enforcement or the application of the police power. The only expense involved would be the cost of making it and when made it would be a source of information to the several councils within the area to guide them in doing their own planning.

What is a Regional Survey?

The Border Cities' area to which I have referred is growing up as one industrial region, with the prospect of having a population of two or three hundred thousand people in the next twenty years. The area is under the local government of seven authorities, one city, four towns and two rural municipalities.

The district that needs to be surveyed comprises all the areas of the first five authorities and those parts of the areas of the last two authorities that lie nearest to the boundaries of the city and four towns and are likely to share in the industrial and residential expansion of the area.

Some consideration has been given to the planning of a comprehensive sewerage and water-supply system for the first five areas by Messrs. Morris Knowles, Ltd., under the instruction of the Border Cities Utilities Commission, representative of all five communities. A plan of the park system is also under consideration. It is doubtful if the Joint Commission will accomplish more than a skeleton outline plan for the guidance of the five municipalities in preparing separate plans in detail for their respective areas. The municipalities may agree to contribute to the cost of a joint plan but may obstruct any attempts to enforce the execution of that part of it which involves cost to themselves and therefore render the plan abortive. Whether or not the planning by a joint Commission is successful, however, it is obvious that a survey made by the Commission will be of great value as the basis either for a joint plan or separate plans.

The fact that the Commission has dealt with different parts of a plan at different times, sewerage and water-supply at one time and parks at another time, and has still to study its comprehensive street plan and the zoning of its industrial and residential areas, indicates that it is likely to waste time and money unless it first proceeds to make a comprehensive survey. I believe its expert advisers will agree with this statement. What then should that survey include?

To answer that question we must have regard to the object we have in view in promoting the development of a district. The first object must be the promotion of industrial efficiency, since the being of the city or district depends on its industries.

Another main object must be the development of healthy housing conditions, since industrial success which is achieved at the expense of the health and strength of character of the people can only be a temporary success so far as the industries themselves are concerned, and can only lead to decay so far as the nation is concerned. Housing conditions mean not only homes but their environment, the protection of their surroundings, the development of recreational facilities near to the homes, the provision of water supply, sewerage, and facilities for transit.

Thus the two main objectives in planning are industries and homes, and the services to make these efficient and wholesome are planning and subdivision of the land for industry and residence, transportation, highways, waterways, sources and distribution of power, water supplies and sewerage, recreation facilities, civic art and general amenities.

First Need. The first need is an accurate topographical map showing the whole natural and structural characteristics of the area as well as the levels of the land. The minimum scale should be 200 ft. to 1 inch, and the contour intervals 5 ft.

Most cities in America are badly equipped in regard to maps. The cost of preparing such maps is considerable and may be estimated at from $1.50 to $2 per acre. Where practical this topographical map should be supplemented by an aerial photographic map taken vertically from the air. The probable cost of such a map would be $200 to $300 a square mile. Oblique photographs of important parts of the area should also be taken from the air.

The topographical maps being prepared, accurate information should be obtained and indicated on a series of prints of the topographical maps. For regional areas this information should comprise the particulars which I collected for the Niagara region of 1,000 square miles in 1918 as follows:

A. Industrial development, including the arrangement and classification of all lands and the location and distribution of manufacturing plants.

B. Economic use and regulation of the subdivision of land and the character and density of structures in rural and urban areas.

C. Housing, sanitation, convenience and amenity.

D. Railways, transportation.

E. Highways.

F. Waterways.

G. Sources and distribution of power.

H. Water supplies and sewerage.

I. Civic art and general amenities, including parks and boulevards.

The object of a survey is not to plan the region but to ascertain and present the data as the basis for proper plan. It can either be followed up by a skeleton regional plan plus a series of civic or local plans, or by separate civic or local plans. A great part of the material needed to make a survey is available in most districts in an uncoordinated form. It has to be collected, coordinated, tested as to accuracy, and arranged in logical order. The making of such a survey is essential to secure final and effective plans of the municipal areas within any industrial or agricultural region, and is the only business-like and practical way to begin operations in city and town planning.

THE ST. LOUIS CITY PLAN

By E. R. Kinsey, President of Board of Public Service

The expression "City Planning" is somewhat of a misnomer as applied to the very important work being done under that name in St. Louis and elsewhere. With very few exceptions, no large city in the world was planned as it exists now, they all "just grew."

It would be a wonderful work to be able scientifically to plan and build a great city; that opportunity will come to very few. The pressing problem now is to re-plan and re-construct our cities so as to meet greatly changed conditions which have come about so suddenly on account of the marvelous development of population, industry, and traffic in a short space of time.

In doing this we can only hope to approximate an idealistic plan by making such changes in existing conditions as are practically possible and which tend to conform to an idealistic plan superimposed on the existing plan.

The most carefully conceived idealistic plan of today will require some modification in the future and the work of re-planning will probably continue indefinitely.

A city built completely in accordance with well conceived plans fifty years ago might be totally inadequate under conditions existing today, and yet who could find a word of criticism for the original planner?

A complete City Plan must concern itself with many problems, the one most evident to the popular eye being the rearrangement of traffic thorofares to relieve street congestion and conserve the time of citizens moving from place to place by whatever means. City-wide plans must be made for the improvement and rerouting of trolley systems for rapid-transit systems. The best location and development of transportation facilities, both rail and water, must be worked out in order to provide for proper and economic industrial expansion.

Residential localities must be protected, living conditions made better and property values conserved thru the enactment and enforcement of a wise zoning law.

Much of this work has been accomplished or is under way in St. Louis. It would be impossible in the time allotted to describe the work in full, but I propose to cover in some detail two features which are fairly illustrative of what intelligent city planning can do for a City.

First let it be said that City Planning in St. Louis is the work of a City Plan Commission. This Commission consists of thirteen men, five of whom are city officials who have duties and responsibilities closely related to city planning and who are ex-officio members of the Commission. The other eight members are appointed by the Board of Public Service and serve without compensation. The Board of Public Service has been fortunate in securing on this Commission the service of men who are leaders in architectural, engineering, medical, and legal professions and in the business world, and these men have given generously and enthusiastically of their valuable time. The working force of the Commission is under the direction of an engineer, Mr. Harland Bartholomew, who is coming to be recognized as a leading authority in this country on city planning.

The Commission took up as one of its earliest problems the development of a major-street system for St. Louis, and it is on this of which I wish to speak more in detail at this time.

St. Louis, like most American cities, started as a small town and greatly expanded over the surrounding territory, the new additions and subdivisions which made up its growth being laid out with streets and avenues which have no relation to a definite plan and frequently little relation to each other. There were a considerable number of wide streets which, because they were not properly connected or did not go far enough, failed to serve any purpose as major thorofares of a big city. There were, however, a number of streets which in their origin were country roads leading to the old town, now the heart of a great city. These, tho interrupted in continuity and inadequate as to width, formed the basis for an excellent system of radial thorofares. A study of the traffic needs of the city developed a sort of conventionalized plan of the city, based largely on existing radial and cross-town streets. A short study of two maps showing this conventionalized plan and the wide streets, respectively, indicates just what should be done to make the existing conditions conform nearly to the idealized plan, and incidentally shows how closely St. Louis will be able to approximate an ideal thorofare-system when the work indicated as necessary shall have been accomplished. The preliminary studies indicate very clearly that all radial thorofare should lead to Twelfth Street, which is a broad street 150 feet in width, extending from Market Street to Washington Avenue, and which in a general way is the western boundary of the congested retail and office-building district. This wide Twelfth Street serves naturally as a distributing thorofare over which traffic is distributed into the streets in the congested district. A map shows the relationship of Twelfth Street to the business district and the creation of radial thorofares in a northerly direction therefrom and also in a southwesterly direction therefrom. The City Plan Commission after careful studies and numerous public hearings brought forth a plan for the northern extension of Twelfth Street to Florissant Avenue. This has been laid out as a thorofare 100 feet wide for its entire length. Plans for this have been approved and enacted into law and the condemnation proceedings are now pending in court.

The most important branch to this radial thorofare is one which will reach and serve a great new industrial district in the northwestern portion of the city in the vicinity of Natural Bridge Road and Union Boulevard. To serve this territory the City Plan Commission has planned the widening of Natural Bridge Road to 100 feet and its extension eastwardly to a connection with the northern extension of Twelfth Street. This work of the City Plan Commission has also been approved and enacted into law and is now in process of court action.

Coming from the southwest and entering the city is a county thorofare known as Gravois Road which enters the city, approaches the business center, and becomes lost in a maze of streets about a mile therefrom. The plan is to widen this thorofare to 100 feet and extend it to a connection with Twelfth Street and the heart of the city. A portion of this work is already an accomplished fact. A study of the traffic approaching the heart of the city from the west leads to the conclusion that it would not be advisable to attempt to concentrate all of it on a single major thorofare. By widening existing streets and by cutting corners, making easy connections, a number of parallel thorofares are being provided. One of these, Olive Street, is being widened to 100 feet from Twelfth Street to Grand Avenue. The necessary legislation for this widening of Olive Street has been passed and the proceedings are now pending in court. Olive Street as widened leads directly into Lindell Boulevard, a broad thorofare which extends from Grand Avenue directly west to the city limits, and thus provides an arterial thorofare from the west.

The traffic congestion in St. Louis is increasing very rapidly, the number of automobiles and trucks increasing at the rate of 25 percent each year, so that it is evident that these thorofares must be established at the earliest possible date in order to keep pace with the rapidly increasing volume of traffic on our streets.

Important as it is to provide for the ever increasing motor traffic the City Plan Commission has not lost sight of the fact that the millions who ride in street cars are entitled to have their time conserved. Studies of the present traffic lines, which follow crooked routes over the present disconnected street system, indicate much room for improvement. So this question has been studied in connection with the establishment of major thorofares and it is planned ultimately to re-route the present lines so that those who ride in trolley cars may have the advantage of more routes from one point in the city to another. The value of the time thus to be conserved runs into an enormous sum of money. The City Plan Commission has also looked forward to the solution of rapid-transit problems and these three factors, namely, motor-traffic, local transportation and rapid transit for all, entered into the determination of the location and widths of the major thorofares proposed.

A second project, to which I desire to call your attention, is what is locally known as the River des Peres plan. This I consider interesting because it shows to what extent real city planning may go. It shows how an intelligent body of city planners may co-ordinate the work of several departments and by making a broad study of the developmental needs of the city, add thereto and develop the whole into a comprehensive plan which will foster the growth of a city to the utmost degree. In the beginning, the River des Peres plan started as a drainage project only. The River des Peres enters the city at its western border a little north of the center of the City and, flowing southwardly thru Forest Park, it wends its tortuous course around the border of the City and within the limits for a distance equaling nearly two-thirds of the western boundary line of the City. As the territory within this drainage area has been transformed from its natural state to urban territory with built up areas and paved streets, there has been a constant increase in the damage occasioned by floods and freshets in the stream. These floods damage existing property and render useless as investment properties considerable areas of land. In addition to this, the unavoidable pollution of the stream has rendered it a menace to health and made imperative the construction of a suitable channel to confine its waters. This was the original problem. City planning, however, recognized the fact that many hundreds of acres, which have not heretofore been used for city purposes because of the River des Peres menace, could be rendered exceedingly useful and valuable by proper development. It became evident on study that the valley of the River des Peres was capable of enormous industrial development and was in fact the last valuable opportunity of great development within the present city limits. It became evident that proper development industrially of this valley required the construction of an industrial railway, and required the extension of thorofares to serve the industries to be located in the valley. A broader view of the whole project developed the fact that, when land was condemned for a right of way for the new proposed channel, there would be left other portions of property which would be much less valuable to its former owners but much more valuable to the city for park purposes. And so the project grew in the minds of city planners, first starting with an excavation within which was to be built the new channel of the River des Peres. Following that the disposition of the surplus earth from its channel into a railroad embankment running parallel to the channel, this railroad first serving greatly to cheapen the cost of the original construction and secondly serving to render valuable all the industrial sites in the valley; then in connection with the acquisition of the necessary land for the channel, acquisition at the same time of lands for thorofares, driveways, and a few small parks, and the construction of certain bridges carrying these thorofares over the new channel. In fact a complete and comprehensive plan for the thoro and final development of the entire section, ready for its ultimate use as a great industrial center, a plan which when worked out and executed as a complete whole will prove far more economical than if carried out piece-meal. This carefully conceived plan, which would cost to execute properly $12,000,000, would make possible the addition of many millions of industrial wealth to St. Louis and perhaps 200,000 in population. In my judgment it is a good example of intelligent broad-minded city planning.

THE ZONING PLAN RECENTLY ADOPTED FOR WASHINGTON, D. C.

By Harland Bartholomew, Engineer, City Plan Commission, St. Louis, Mo., Consultant, Zoning Commission, Washington, D. C.

The casual visitor to Washington cannot but come away deeply impressed with the great beauty of our National Capital. We look to Washington as the ideal of beauty and harmony in civic design—one of the few cities of the world that have been built from a plan prepared in advance of the city's upbuilding. To one more familiar with our National Capital the spectacular attractiveness of the city becomes greatly diminished when contrasted with the many unfortunate results of haphazard growth that can be seen in many of the commercial and residential areas. In no city is there greater evidence than in Washington that a reasonable control over the development of private property must be exercised in order to insure economy, uniformity and desirability of city growth. Probably nothing of greater importance has been or will be done to control the future of our National Capital since Washington and L'Enfant prepared the plan of the original city than the adoption of the zoning plan on August 30, 1920.

On March 1, 1920, Congress passed an act providing for the Zoning Commission for the District of Columbia, consisting of the Commissioners of the District of Columbia, the officer in charge of public buildings and grounds of the District of Columbia and the Superintendent of the United States Capitol Buildings and Grounds, appropriating $5000 for the work of the Zoning Commission and requiring that a plan be prepared not later than September 1, 1920. The limited time and funds provided presented to the Commission a task greater than that heretofore confronted by any similar body. Practically all cities the size of Washington heretofore preparing zoning ordinances had ample time at their disposal and sufficient funds to undertake work deliberately and carefully, the zoning ordinances prepared in other cities usually having heretofore involved studies covering one year at least. The work in Washington would have been impossible had not Congress provided that employees of various departments of the government of the District of Columbia might be assigned to duty with the Zoning Commission.

Owing to pressure of work in the District it was impossible to undertake zoning work previous to May 1, when a definite program was outlined and a staff of approximately ten draftsmen secured. The program adopted involved the completion of the principal study maps by July 1, the preparation and tentative approval of the zoning regulations, and the height-, area- and use-maps by August 1; hearings to be held on August 9-14; revision and official adoption of the zoning regulations and height, area and use zone-maps August 30. This program involved exceptionally heavy duties on the part of the Commission and its staff, but was rigidly adhered to thruout.

Not the least difficult task confronting the Commission was the educational work necessary to acquaint residents of the District of Columbia with the purposes and details of the zoning plan, to the end that the plan might insofar as possible meet with widespread approval. For this purpose the District of Columbia was arbitrarily divided into 16 sections, in each of which a Citizens' Committee was appointed, thru whom the Zoning Commission could secure information with respect to neighborhood approval or disapproval of the plans proposed. These committees functioned well and without doubt assisted greatly in securing the widespread approval of the zone plan adopted by the Commission. One of the most satisfactory and gratifying features of the work was the unusual amount of space devoted to the work of the Commission by the several newspapers of the District, some of which published in readable size practically all of the maps, both tentative and final, prepared by the Commission. So effective had been the work of the neighborhood committees and the newspaper notices that only a few of the hearings were attended by any considerable number of persons.

Contrary to the procedure usually necessary in other cities, the Zoning Commission of Washington was empowered by Congress not merely to prepare a zoning plan but to adopt it after public notice and hearing, its enforcement being in the hands of the Commissioners of the District of Columbia, each of whom is a member of the Zoning Commission. There is no legislative body corresponding to a city council or board of aldermen in Washington. The government of the city is in the hands of three men appointed by the President and confirmed by the Senate, one of whom is an army officer from the engineer corps. Despite the great amount of authority vested in the members of the Zoning Commission, to their credit be it said that no more effective or conscientious attempt to acquaint the citizens of a city with the purposes and details of the zoning plan or more responsive action taken in accordance with public sentiment or individual opinion, has attended the preparation and enactment of a zoning plan in any other American city.

The provisions of the Washington zone plan may be briefly described as follows:

There are four use-districts:

1. Residential district
2. First commercial district
3. Second commercial district
4. Industrial districts

In the residential district buildings may be used for dwellings, apartment houses, hotels, churches, clubs, institutions, etc.; farm and truck gardening, nurseries and greenhouses are also permitted as well as the excavation and removal of sand, gravel or clay; accessory buildings customary and incidental to the foregoing uses are also permitted, including a private garage containing not more than four automobiles. A public garage having no repair shop is also permitted in a residential district when complying with a very rigid consent rule heretofore adopted. It was deemed necessary to admit public garages to residential districts owing to their great area, the consent rule now in force having operated to prevent any unusual abuses of such a privilege. In this connection it is interesting to note a provision requiring that all garages located in residence districts be removed at least 50 feet in case of private and 75 feet in case of public garages from any street building-line.

In the first commercial district, which constitutes portions of the principal radial thorofares as well as a considerable section of the principal business district, buildings may be erected and property used for the usual types of retail stores and shops but excluding blacksmith, bottling works, cooperage, lumber-yard, livery stable, public garage and automobile repair-shop (except when complying with the consent rule), stone-yard, junk-yard, uses excluded from the second commercial district and any kind of manufacturing other than the manufacture clearly incidental to a retail business conducted on the premises. Bakeries or laundries employing more than five persons, a milk distributing station or a public garage with only incidental repair facilities are permitted in the first commercial district upon written consent of the owners of 75% of the property within a radius of 200 feet.

The second commercial district is greatly limited in area and usually confined to the property bordering railroads which is now used for or in the future would be unsuitable for any use other than manufacturing purposes. An extensive list of objectionable types of industries are excluded from the second commercial district.

In the industrial district buildings and premises may be used without restriction except those already imposed by law or municipal regulation. Industrial districts are greatly limited in area, being confined to narrow belts along the railroads where heavy industries have already been built.

There are four height-districts as follows:

35-foot height district
55- " " "
85- " " "
110- " " "

The 35-foot height district embraces practically all one-family detached residential districts of Washington and the outlying suburban areas as yet undeveloped. In this district a one-family house may exceed 35 feet height restriction by no more than 10 feet by providing two side yards of 15 feet each.

The 55-foot height district contains those sections of the old city of Washington now occupied by three- and four-story houses and apartments.

The 85-foot height district includes practically all of the wide streets within the old city limits, the higher value property surrounding the principal business district and the industrial areas.

The 110-foot height district includes the principal down-town business district with such areas as this district will expand in.

For many years Washington has had a very detailed plan of regulating the heights of buildings, depending in general upon the width of the street. With the exception of Pennsylvania Avenue, upon which buildings 160 feet high could be built, no building elsewhere in the District of Columbia could exceed 130 feet in height and this only on streets 110 feet wide within the business district specifically designated as business streets. There never seemed to have been any great reason for exceptional height on Pennsylvania Avenue and only comparatively few buildings within the business district have even taken advantage of the maximum height limitations of 130 feet. Considerable objection was voiced to a reduction in the height limit from 130 feet to 110 feet, in fact the only real objection to the entire plan expressed at the hearings having been with regard to the reduction of height limit. After mature deliberation the Zoning Commission felt justified in establishing a 110-foot height limit.

There are four area-districts as follows:

1. "A" area district
2. "B" " "
3. "C" " "
4. "D" " "

The "A" area district includes areas to be developed for detached and semi-detached homes. A rear-yard and one side-yard are required. Buildings may occupy 40% of an interior lot and 50% of a corner lot.

The "B" area district is intended primarily for areas which will develop with row-houses and small apartments. A rear-yard is required. Buildings may occupy 60% of an interior lot and 70% of a corner lot.

The "C" area districts are intended for areas to be developed with larger apartment houses and stores and shops in the first commercial district. Commercial buildings may occupy 100% with the first floor, otherwise buildings shall not occupy in excess of 75% of the interior lot nor in excess of 90% of a corner lot.

The "D" area district includes the high-value down-town business district, the second commercial district and the industrial district. A rear-yard is required on interior lots above the first floor where lot occupancy of no more than 90% is permitted.

For all tenements or apartment houses hereafter erected two side-yards are required, of dimensions complying with the district within which such tenement- or apartment-house is located.

In order to encourage a desirable type of the less expensive forms of group housing now becoming more or less prevalent, a proviso was added that the requirements of side and rear yards might be waived for a community house containing no more than three individual buildings where two side-yards and a rear-yard of not less than 10 feet each were provided and otherwise complying with the area requirements of the district in which located.

Non-conforming uses existing at the time of the adoption of the zoning regulations are permitted to continue but in accordance with the act of Congress no structural alterations may be made in non-conforming uses except such as may be required by law or regulation. No new buildings may be erected in connection with non-conforming use. The act of Congress is more specific and restrictive in this connection than any other zoning law or ordinance. It practically assures complete conformity with the zoning plan by all buildings within a reasonable period, i.e., the life of existing buildings.

One of the interesting features of the Washington work has been a definite determination of the district boundary lines both for height, area and use of buildings and premises upon a set of real-estate atlases secured especially for that purpose. While the zoning regulations and a set of maps will be published for general circulation, there nevertheless exists a final record of the exact boundaries of the districts in the determination of which many inaccuracies or inconsistencies were avoided, which undoubtedly would have occurred in a series of small-scale maps.

The Zoning Commission of Washington becomes under the act of Congress a continuing body. While the Commissioners of the District of Columbia are charged with enforcement of the zoning regulations, appeal from the action of the Commissioners of the District of Columbia may be taken to the Zoning Commission. Thus the Zoning Commission becomes in effect a Board of Appeals in whom also rests the power to initiate changes in the plan now adopted, either by their own motion or upon petition. Interesting in this respect is the provision in the Act of Congress that where a petition for a change in a district occurs which is not contiguous to a similar district, the owners of at least 50% of a frontage within an area not less than 3 blocks in length must join in such petition before it may be considered by the Zoning Commission.

The personnel and staff of the Zoning Commission for Washington, D. C. was as follows:

Col. C. W. Kutz, Engineer Commissioner, D. C., *Chairman.*
Louis Brownlow, Commissioner, D. C.
Col. C. S. Ridley, Superintendent, Public Buildings and Grounds, D. C.
Elliot Woods, Superintendent, Capitol Building and Grounds
Major Roger G. Powell, Asst. Engineer Commissioner
Major Carey Brown, Asst. Engineer Commissioner
Harland Bartholomew, Consultant.

THE RELATION OF ZONING TO THE WORK OF THE CITY ENGINEER

By E. S. Rankin, Chief Engineer of Sewers, Newark, N. J.

The latest municipal activity, the zoning of cities, a movement which is growing rapidly in favor thruout the country has been advocated chiefly on account of its effect in stabilizing property values and to a somewhat less extent as a health measure. There is no question but that these two reasons alone are ample justification for stringent laws governing the height of buildings, the location of residence and industrial districts and the percentage of lot area permissible for building purposes. Our citizens should be protected in their inherent right to light and air, and our homes from the possibility of a noise- or nuisance-producing industry on the adjoining lot.

But there is another feature of the movement, which is the subject of this paper, a feature which does not seem to have received the recognition to which it is entitled and which should be of peculiar interest to this Society composed as it is largely of municipal engineers.

In a city in which a stringent zoning ordinance is in force, the element of chance in the engineer's work is largely eliminated and decided economies are effected, whether it be in the laying out of streets, or in their paving, sewering, or water supply, for it is obvious that with the assurance that a given section of the city will be occupied by a certain definite class and size of buildings, the engineer can much more intelligently design the public works necessary to serve that section properly.

In the final report of the New York Commission on Building Districts and Restrictions, Mr. Nelson P. Lewis has this to say in regard to the opening of streets in undeveloped territory: "One of the serious problems confronting my office in passing upon street plans has been the need of providing what may be an excessive width of streets where land is cheap, for fear that the building of a new transportation line, putting the land in close touch with the business center, will result in an intense development by apartment houses, so that we have been obliged to guard against conditions which formerly prevailed on the east side of Manhattan and to insist upon a minimum street-width which is more than the real need of the territory if reasonably restricted. If such development were confined for instance to two- or three-story houses or in some cases to detached houses, we would not have been obliged to impose upon the property-owners the cost of acquiring and then improving streets of greater capacity than they would need if there were some sane, reasonable plan for preventing over intensive development."

In another part of the report the same author says: "This City has suffered tremendous losses by the inflexibility of its street system which, instead of controlling a subdivision, has been controlled by the habit of creating lots of 100 feet deep lying between streets 200 feet apart, and great enterprises,—finding themselves hemmed in by rigid street systems, have been obliged to find new sites on the New Jersey Meadows."

With a zoning ordinance in effect a street system can be laid out with streets of such width and such distances apart as best to serve the use to which the land will be put, and with the assurance that such use will be permanent. Parks and playgrounds can also be located where they will permanently be of the greatest service to the greatest number.

Perhaps the most obvious effect which zoning will have on public improvements will be in its relation to the paving problem.

In an industrial district durability and strength to carry the heaviest traffic will be the first consideration, while smoothness with an absence of noise will govern the selection of a pavement for a residence district. Of course these features are given consideration without a zoning ordinance, but there is no assurance that the character of the district will not change and the pavement become unsuitable. The writer has in mind a street in his own city paved a few years ago with telford. The street was well built up at the time with moderate sized one- and two-family detached houses, but adjoining a new railroad spur. Almost immediately following the paving of the street factories began to appear, attracted by the railroad, with the result that inside of a year the pavement was sadly in need of repairs and soon had to be replaced with more durable material. Had the street been restricted by a zoning ordinance to its original character, the pavement would have served every purpose for a number of years, or had it been definitely placed in an industrial district the mistake of laying a telford pavement would never have been made.

The effect of zoning on sewer design, with the substitution of known factors for estimates based on the judgment of the engineer, is very marked. For most of the remarks on this phase of the subject I am indebted to an article by Mr. W. W. Horner, vice-president of this Society, in the report of the City Plan Commission of St. Louis for 1919.

The three factors governing the cost of sewers, length, depth and size are all affected by the character of the district to be served. In a small-house residence district, all streets must have sewers and, following the modern custom, connections must be laid to the curb for each lot approximately 25 feet in width. For apartment houses, residences restricted to large lots, business or light manufacturing districts, the connection may be placed farther apart, while for heavy industries, one or two to a block are sufficient, and in some blocks even main sewers may be unnecessary.

One- or two-family houses and industrial buildings usually have cellars not to exceed four to five feet in depth below the curb, hence a shallow sewer will serve every purpose, while apartments and particularly commercial buildings require much deeper sewers.

The necessary size of a sanitary sewer, omitting the factor of grade, being governed entirely by the number of people served, can be determined very accurately, knowing the permissible height of buildings, and the proportion of building to lot area and particularly when, as is the case with the Newark ordinance, the maximum number of families allowed per acre is specified.

In estimating the required size for combined and storm sewers by the so-called national method the uncertain but important factor of impervious area becomes a known quantity. As is well known, this factor may vary from 100% for entirely built up areas down to 30% or even less in suburban districts.

Without definite restrictions it is necessary to estimate the possible maximum length, depth and size for all parts of a city alike, but with a zoning ordinance in effect each section can be treated separately and sewers built to properly sewer such section alone. Mr. Horner estimates that from ten to fifteen per cent of the cost of the St. Louis sewers could have been saved had a definite plan for the development of the areas been adopted when the system was designed.

With the exception of the factor of depth, similar remarks would apply to the water-distribution system. It would appear therefore that the municipal engineer should be one of the foremost advocates of the zoning of our cities.

PITTSBURG PROBLEMS IN CITY PLANNING DUE TO RUGGED TOPOGRAPHY

By N. S. Sprague, Chief Engineer, Bureau of Engineering, Pittsburg, Pa.

(Synopsis)

Most of our large American cities are so favorably situated that the problems of city planning relate principally to the questions of expense and the ability of the community to assume the obligation. In other words, natural barriers to expansion and growth, presenting serious engineering problems, are not generally the controling elements in city planning.

The City of Pittsburg, however, where considerable city planning work is now in progress, presents difficulties which are uncommon in the average American city. This is, in a large measure, due to the irregular and rugged topography of the city. The range in elevation between the lowest and highest parts of the city is 670 feet.

The city has an area of 42 square miles and outside of the down-town and East Liberty districts, it is estimated that between 30 and 35 per cent of the area is unsuited for development of any kind. Large rivers, creeks, and deep ravines separate the city into different sections, and the hills also prevent convenient access from one part of the city to another. In common with other cities, the river banks have been taken over by the railroads, industrial plants and steel mills and, therefore, the possibility of any extended water-front development has long since passed.

Another element increasing the difficulties of affording relief to traffic, is the restricted area of the down-town district. The business center of the city is a triangle (known as the Golden Triangle), having an area of 218 acres. Of this 218 acres, 68 acres are occupied by streets and alleys. The assessed valuation is $85,910,000.00 and the taxes paid, including school tax and water rates, are $2,186,000.00 per year.

There have been no extensive improvements made in the city since the completion of the 1910 program. The need of additional streets and the widening of existing ones to relieve traffic congestion was recognized soon after the completion of the 1910 program. A bond issue was submitted to the people and passed in July, 1919, providing funds and authorizing the expenditure of $10,560,000.00 for street improvements. Some of this work is already in progress and plans have been prepared for the rest of it. Typical street improvements were discussed, with the aid of lantern slides, showing difficulties, due to topography, existing development and methods of payment.

TRANSPORTATION AND THE CITY PLAN

By Nelson P. Lewis, Chief Engineer, Division of Public Improvements, Board of Estimate and Apportionment, New York City

The word "transportation" is used in its broadest sense in this paper, the purpose of which is to point out the relation between it and the city plan, and the need of considering not only existing needs and means of transportation, but those which are likely to come with future growth and improved methods. It is not proposed to describe existing conditions or specific places, but to deal only with general principles.

We are likely to think of transportation as the conveyance of persons or goods, usually by public service corporations under a certain degree of regulation and control by federal, state or municipal authorities, across or along navigable waters or by railway lines owned or operated by the carriers. We are too prone to think of carriage by water and by land as distinct and independent operations, and even of that performed by an individual carrier as disconnected from that done by another under different ownership and management.

Terminals and Street Traffic

We speak of "terminals," a word that is and probably will continue to be used to designate the limit of a particular transportation facility in one ownership, as though they represented the ultimate goal of the thing transported instead of merely the end of one step in a long journey, or of one in several journeys, it may be, from field, forest or mine to places of manufacture or combination with other things, and then of the finished product to points of distribution and of final consumption or use. We forget, too, that no inconsiderable portion of this journey is thru public highways, where it is mixed with miscellaneous street traffic, to the inconvenience and delay of both. The amount of transportation in the public highways has greatly increased in recent years owing to the rapid development and the demonstrated efficiency of the motor truck. The volume of such traffic in the congested parts of cities is greater than it would be if the so-called terminals of water and rail transportation lines were properly co-ordinated and planned on sufficiently generous lines. Improvements to such terminals, and their suitable interconnection, would remove some of this traffic from overcrowded city streets.

The system of store-door delivery, which has been successfully used in some places and is believed to have great possibilities of economy and efficiency, should not increase the amount of heavy trucking in commercial districts, as it would tend to substitute for a great number of trucks operating under private management and with much lost motion, a smaller number better organized and more intensively used.

MOTOR TRAFFIC WILL INCREASE

In suburban and rural districts the motor transportation on public roads will doubtless continue to increase in volume, and the trunk line highways should be planned with this in view, giving them adequate width, so that the paved portions may be expanded when necessary, without the need of acquiring additional property, always a costly procedure which, in most cases, can be avoided by the exercise of foresight. This applies to interurban roads, often passing thru extensive agricultural districts or undeveloped areas, as well as to the suburban sections of these roads as they approach important centers of population.

In this paper consideration will be devoted almost entirely to transportation by railway, and the need of suitable provision for railway terminals (using the word in its generally accepted sense rather than with its literal meaning), and of the co-ordination of different transportation lines in order that the facilities of all lines may be availed of by the shipper or receiver of goods at a minimum of cost, time and inconvenience. If a merchant receives goods from several different sections of the country, or if a manufacturer wishes to make shipments to as many points, he should not be compelled to go to a different part of the city to receive or deliver freight arriving or leaving by different lines. He should be able to use the nearest and most conveniently located freight station, whatever may have been the origin or whatever may be the destination of his goods, or by whatever line they may be carried. This is a fundamental economic principle which holds good whether the town be large or small, and whether the transportation lines serving it be few or many.

ROOT OF RAILWAY EVILS

During the boom period of town's growth every new railway line which seeks an entry is welcomed with open arms, and is allowed to come in as it wishes, to cross streets at grade and to establish its terminals where land is cheapest and the cost of construction is lowest. The result is a number of independent and disconnected freight terminals, subsequent connections between which become increasingly difficult and expensive as the city grows.

If a town is a seaport or on a navigable waterway, little or no thought has heretofore been given to the co-ordination of the shipping and railroad facilities. The fact that they are a single problem has for some years been appreciated in Europe and in South America, as will be seen from a casual examination of the plans of such seaports as London, Liverpool, Hamburg, Rotterdam, Antwerp, Havre, Buenos Ayres and Rio de Janeiro, and even such inland ports as Duisburg-Ruhrort and Frankfort-on-the-Main.

Most of our cities were not planned as we now understand the word "planning." The site was surveyed when people began to make their homes and establish their business there and series of streets were laid down for the original settlement and its successive additions. If a railroad was already there, the streets were quite likely to have been laid out across and parallel with the railroad, which may have been left as a conspicuous feature of the main thorofare—a condition which often survives for many years—as is the case in Syracuse, N. Y., where the railroad still occupies the surface of an important street, altho its removal has long been discussed and many plans have been made to accomplish this result.

BEST LOCATION FOR TERMINALS

But let us assume that our cities are to be planned, or at least that their future development is to be guided in an intelligent manner, and the blunders due to lack of a proper plan are gradually to be corrected in so far as it is possible to do so. One of the first questions which will present itself is the best location for railroad passenger and freight stations, or terminals, as they are commonly called. Should they or should they not be placed as near as possible to the business centre? This question was discussed by Col. William J. Wilgus, formerly chief engineer and vice-president of the New York Central Railroad, in a paper presented at the City Planning Conference, held in Cincinnati in April, 1920, which formed a part of the report of the Special Conference Committee on Railroad Terminals. He states the case so clearly that the writer ventures to quote him at some length, as follows:

"The advantages" (of placing them near the business center) "are convenience to that portion of the traveling public which can most easily complete its journey on foot, and, in the case of freight, a slight saving in time and expense because of shortness of haul by motor truck between the freight station and the point of origin or destination.

"The disadvantages are the maintaining for railroad purposes, in the midst of the city, of vast wastes which block orderly civic expansion and contribute largely to the congestion that increasingly is becoming such a fruitful source of delay, inconvenience and expense to the public.

"If, as in the case of the Grand Central terminal at New York, the railroad approaches and station can be placed beneath the surface, so that streets may be carried overhead without interference with the city's normal development, and if it is practicable to move trains by electricity so as to do away with nuisances incident to the use of steam locomotives and thereby permit the utilization of valuable 'aerial rights' for revenue-producing purposes, the better solution may be the placing of the terminal as near as possible to the business center.

REMOVAL MAY BE NECESSARY

"If, however, the underground treatment is impracticable and if the number of railway lines and the shape of the city are such as to make undesirable this manner of solution, the courses to pursue would be the banishment of the passenger terminals from the heart of the city to points sufficiently removed therefrom to afford ample space at moderate cost for the stations and yards, with contiguous parks, all planned in such manner as not unduly to interfere with future city growth.

"In the case of local freight terminals the advantages of having them well removed from the business center would seem by far to outweigh the small advantages of a shortened haul for the motor truck. A larger portion of the expense of freight distribution lies in delays to trucks awaiting opportunities for loading and unloading at the terminals, due to restricted facilities and congested surroundings. This situation is constantly becoming worse, and is contributing in a large degree to the high cost of living in great cities. Instead of continuing the journey of the railroad car as close as possible to the business center, with the attendant high cost of property and of operation, coupled with congestion and general inefficiency, for the sole purpose of shortening the haul by motor truck, it would be better to shorten the railroad haul somewhat, lengthen the haul of the motor truck and place the points of interchange where cheap lands abound."

Col. Wilgus suggests the interconnection of two or more passenger terminals located at points comparatively remote from the business center, such connecting tracks in turn to be brought in close touch with all parts of the city by means of a system of urban rapid transit lines. Similarly, it is proposed that freight be moved by electrically operated multiple-unit cars of, say, 10-tons capacity from trans-shipment points on the various railroads serving the city thru sorting yards and then thru freight subways under the city streets to various points where the car bodies could be transferred from the subway vehicles to the chassis of motor trucks for short-radius surface distribution. This would remove the unsightly freight terminal yards from the central parts of the city to districts given up to industrial development and where they would be in keeping with their surroundings.

MUST RECOGNIZE RAILWAYS' IMPORTANCE

The dependence of the city's development and growth upon the railways serving it must be admitted and every opportunity consistent with the orderly expansion of the city and with the health and convenience of its citizens should be given the railroads to render this service. The importance of the railroad must be recognized. It cannot be kept out of sight and it cannot be wished away. Its existence presents some difficult problems, especially in the relation of the railroad to the street system.

Railroads built thru thinly settled districts which produce little business for them are obliged to keep their original construction cost down to the lowest possible figure and to provide for betterments from their future earnings, and this policy is often followed even with respect to the portions of their lines entering or passing thru urban districts. This means numerous grade crossings, which, of course, must be eliminated, while additional crossings at grade must be prevented. Nearly all states have enacted laws dealing with this problem, forbidding additional crossings and providing for a division of cost of grade separation between the railroad company, the state and the municipality.

Work of this kind involves such great expense that it cannot be carried out in a wholesale fashion, but must be undertaken progressively. It is a mistake, however, to consider each crossing or each group of crossings as a separate problem. A comprehensive scheme should be worked out in advance, altho the execution of the work may be deferred for years. On one portion of the line it will be found better to elevate the railroad and depress the street, and in another section it will be found better to carry the streets over the railroad. When the intervening section is taken up, where the railroad passes from cut to fill, it may be found impossible to carry some important streets either over or under the railroad, while, had the problem been studied in a more comprehensive fashion, more satisfactory results could have been attained. Having determined whether the street is to pass over or under the railroad in each case, the clearance required for street and for railroad, and how much the grade of each is to give way to that of the other (the last often being an especially difficult question to settle), the character of the structures is to be considered.

APPEARANCE OF RAILWAY STRUCTURES

Where the highway is carried over the tracks, little of the structure besides its roadway, sidewalk and protecting railing will be seen and the chief consideration will be adequate capacity and safety, but where the railroad passes over the street the appearance of the structure must be considered. It need not be monumental or imposing, but, on the other hand, a structure which will simply get the tracks across the street and permit traffic to pass under it without regard to its appearance, should not be tolerated.

Railroad stations, yes, even freight stations, should be recognized as public buildings and as such they ought to reflect credit upon the city. This is generally recognized in the case of great passenger stations. In architectual design and in the convenience of their internal arrangements some of them leave little to be desired, though they have not the commanding position with respect to the streets approaching them which is found in some European cities.

GENERAL CONSIDERATIONS

The Committee on Railroad Terminals of the National Conference on City Planning, already referred to, presented at the Cincinnati Conference certain general considerations which will be repeated as the conclusion of this paper.

1. Unified control and operation of all standards railroad lines within the limits of any city is essential both to the requirements of modern business and to the convenience of the public. It should be brought about with as little delay as possible, at the same time providing opportunities for expansion both of trackage and terminals in connection with a well-considered plan of city development. Means should be found and taken for persuading or compelling all railroads entering the city to connect with such a unified system at the city limits. The entire question of railroad service should be considered as a whole, not with relation to one system or one part of the city only.

2. The present wasteful and needless duplication of lines and terminals inside of city limits cannot be permitted to continue. Many cities can show millions of dollars spent in unnecessary duplication of passenger stations, when the same sums expended in added industrial lines would have increased both the business of the carriers and the prosperity of the city. This is a useless drain on the railroads, resulting in additional cost of operation, for which the public pays. It is a needless inconvenience to the public which can be remedied at comparatively small cost by proper co-operation in planning by both the city and the railroads. Voluntary action on the part of one road is not to be expected and is generally impracticable. The city, with the aid of the state or national government, holds an advantageous position to undertake bringing the railroads together for such intra-city unification.

3. All shippers within the city should be free from dependence on one road for cars. In some cities shippers now have to maintain needless additional warehouses on a second line in order to insure prompt delivery of cars on the first line. This is a wasteful expense, which must be added to the cost of shipping and doing business, particularly where a perishable product is involved.

4. All spurs and industrial tracks within the city limits should be "common user" tracks, served by a belt line connected with all main lines entering the city, a fair pro rata return being made to the original owner of each line for such use.

5. Municipal ownership of intra-city lines is probably not necessary, provided there is unified control. Expansion of existing terminal companies to include all lines within city limits is probably the most economical, quickest and easiest method of accomplishing unification in most cities. New trunk lines should be allowed to hook onto the city terminal lines at the city limits at any time in the future. This would provide for competitive lines thru the country without cutting the city into further pie-shaped sections, or causing further blighted areas to property within a block or two of each side of the railroad right-of-way thru a city, as at present.

6. Provision of complete modern business facilities is essential to all industries. Railroad service, while important, is not the only

one of these facilities necessary. Protected industrial districts or zones appropriately and conveniently situated, free from hampering residential requirements, with wide, heavy-hauling pavements, high-pressure fire protection, extra large sewers for industrial wastes, etc., as well as unlimited spur tracks, are necessary in any city of consequence, and many of the progressive cities of the country have already established such zones. The fullest co-operation between the city and the railroad is necessary to make the facilities in these zones most useful in the development of business. Once such zones are established, both railroads and shippers can feel safe in concentrating large investments for permanent ultimate service not otherwise justified.

7. One of the greatest opportunities for railroads to cut down expenses and freight rates is by simplification of terminals. On most of the big roads it costs as much to get a car of freight out of the city limits as it does to haul it 250 miles or more on the main line. Some roads report as much as 35% of their total freight cost in handling at terminals (from reports of O.W.R. & N.R.R. to Oregon Public Service Commission). This is by far the biggest single item to the railroads in their cost of doing business. A small saving, therefore, in terminal handling should effect a considerable amount of saving in freight cost and should be welcomed by railroads and shippers alike.

8. Whatever the origin or destination, a merchant or manufacturer should be able to receive and ship at the freight station which entails the shortest team haul.

9. Adequate expanded classification and freight yards must be provided in every city as part of its future plan as an adjunct of industrial development. These yards should have long areas uninterrupted by grade crossings, preferably located at one side or on the outskirts of the city, away from the probable expansion of business and main street-traffic lines. Main railroad lines should be diverted around the city, and outside the city limits, wherever practicable, so that thru freights and other thru trains need not pass thru the congested parts of the city. In light of the development of modern street transit, consideration should also be given to the possible advantages of relocating main passenger and freight stations away from the congested districts.

10. In cities which have water-borne commerce, whether coast or inland ports, rail and water terminals should be considered as a single rather than as separate problems; co-ordination of facilities for both methods of transportation should be insisted upon in the interest of the public and of the carriers themselves.

11. The relation of the railroad to the street system of the city should be carefully worked out. The value of the railroad to the prosperity and the very life of the city should be recognized. Wide heavy-hauling pavements to freight terminals, docks and the industrial zones are equally essential, and form a natural and im-

portant complement to the greatest use of railroad facilities. Direct and amply wide traffic thorofares should lead to all principal passenger and freight stations.

12. The elimination of grade crossings on both steam and electric rapid-transit lines is essential to public safety and convenience, to prevent the interruption of traffic and for the proper conduct of business. The problem of grade-crossing eliminations should be studied in the most comprehensive way and not in a piecemeal fashion, even tho the execution of the work is to be carried out gradually.

13. The fullest co-operation should be given cities by the railroads in planting and improving the appearance of borders of rights-of-way, yards, bridges, viaducts, stations and terminals within the city limits. Much of the present damage to adjacent property values and rentals can be done away with in this manner, at reasonably small expense, by closer working together of railroad officials, park boards and other city officials.

14. These fundamental considerations in the relation of railroads to city development, we respectfully commend to railroad officials, city plan commissions, state public service commissions and the distinguished members of the Interstate Commerce Commission, with the conviction that the grave questions of economy and public policy involved merit their fullest concurrence and co-operation.

SUGGESTIONS FROM FRENCH PRACTICE IN MUNICIPAL IMPROVEMENTS

By George B. Ford, Director of City Planning Department of the Technical Advisory Corporation, New York City

---

I wish you would take a trip to-day thru northern France. It is one of the most inspiring things you could do. The French are coming back. We knew they would, but their achievement in the face of the most appalling destruction the world has ever seen is astounding.

An area as big as Massachusetts, Rhode Island and part of Connecticut was laid waste, but already two-thirds of it is back under cultivation. More buildings were destroyed than in the whole of Greater New York and yet not only is almost everything repairable back in use but complete reconstruction is well underway. Three-quarters of the factories are again in operation.

Enough miles of railroad were destroyed to reach from New York to San Francisco, but almost all is not only back in use but is handling much more freight than before the war. 1800 bridges were destroyed. Almost all are rebuilt and better and more modern than before the war. They are profiting by the destruction of several hundred miles of canals to prepare them to take 600-ton barges instead of 300 tons. Whole mountain-sides are being blasted away to repair the destroyed tunnels, and great arched concrete retaining embankments are being constructed.

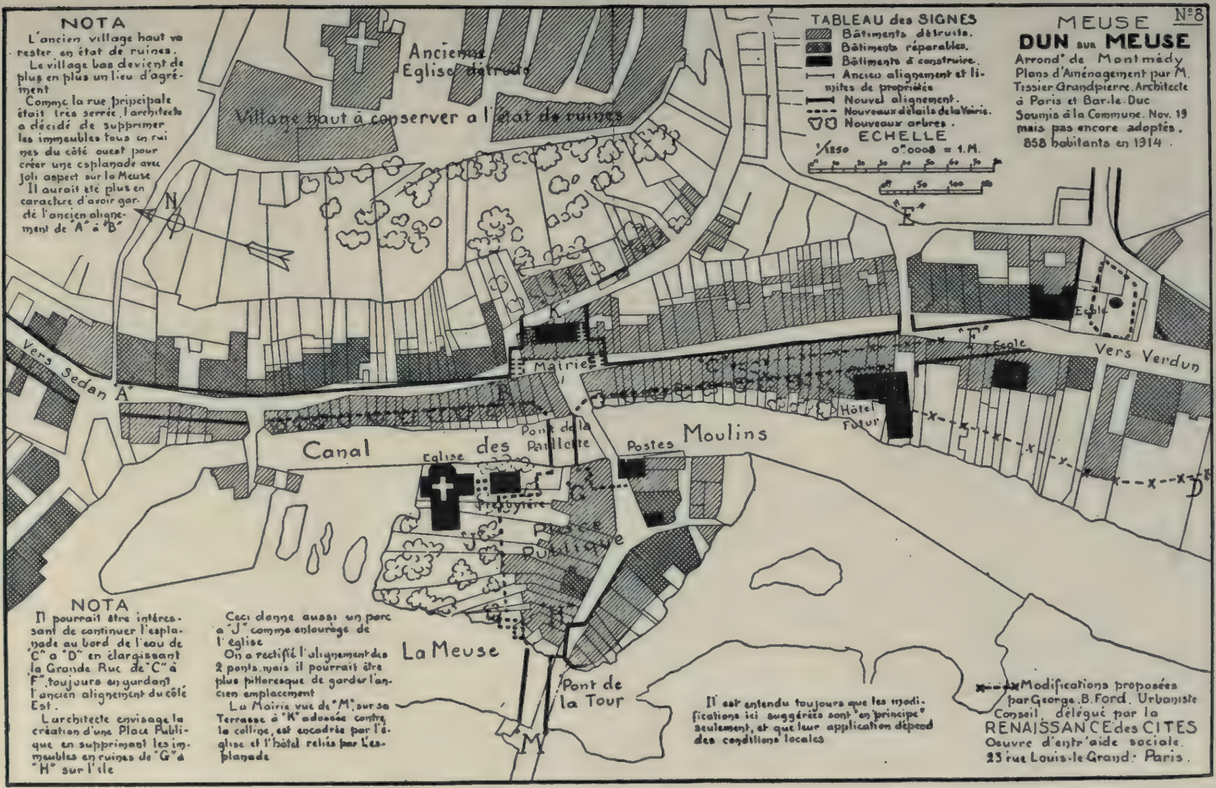
In their haste to get back on their feet are they just putting back what was there before the war? Far from it, they are profiting by the occasion to correct the mistakes of the past and to start fresh.

Chauny was a knee-high town blown up systematically by the Germans because it was an important industrial city; a menace to German trade. La Renaissance des Cites held a competition for plans for its improvement. The remarkable prize plan has been officially adopted by the city. It creates a large factory-district between the railroad and the canal with workingmen's model home communities within easy walking distance.

Soissons, always under fire during the war, is profiting by the destruction to replace some of her tortuous streets by broad traffic arteries. Arras, Verdun, Cambrai, etc., are doing the same.

Lille, the great industrial center of northern France is tearing down her choking walls and changing her terminal passenger-station into a modern thru station and now she is holding a great competition for the planning of all of the contributing area.

Rheims is the first city in France to have its comprehensive city plan adopted by the French Government. In these plans I have


NOTA
L'ancien village haut va rester en état de ruines.
Le village bas devient de plus en plus un lieu d'agrément
Comme la rue principale était très serrée, l'architecte a décidé de supprimer les immeubles tous en ruines du côté ouest pour créer une esplanade avec joli aspect sur la Meuse
Il aurait été plus en caractere d'avoir gardé l'ancien alignement de "A" à "B"
N
Ancienne Eglise détruite
Village haut à conserver a l'état de ruines
TABLEAU des SIGNES
Bâtiments détruits.
Bâtiments réparables.
Bâtiments à construire.
Ancien alignement et limites de propriétés
Nouvel alignement.
Nouveaux détails de la Voirie.
Nouveaux arbres.
ECHELLE
1/1250 0m.0008 = 1.M.
MEUSE
N°8
DUN sur MEUSE
Arrond^t de Montmédy
Plans d'Aménagement par M. Tissier Grandpierre, Architecte à Paris et Bar-le-Duc
Soumis à la Commune. Nov. 19 mais pas encore adoptés.
858 habitants en 1914.
E
Ecole
"F"
Ecole
Vers Verdun
Vers Sedan
A
"K"
Mairie
B
C
Hôtel Futur
D
Canal des Moulins
Pont de la Paillette
Postes
Eglise
Presbytère
G
Place Publique
J
H
La Meuse
Pont de la Tour
M
NOTA
Il pourrait être intéressant de continuer l'esplanade au bord de l'eau de "C" a "D" en élargissant la Grande Rue de "C" à "F", toujours en gardant l'ancien alignement du côté Est.
L'architecte envisage la création d'une Place Publique en supprimant les immeubles en ruines de "G" à "H" sur l'île
Ceci donne aussi un parc a "J" comme entourage de l'eglise
On a rectifié l'alignement des 2 ponts, mais il pourrait être plus pittoresque de garder l'ancien emplacement
La Mairie vue de "M", sur sa Terrasse à "K" adossée contre la colline, est encadrée par l'église et l'hôtel reliés par l'esplanade
Il est entendu toujours que les modifications ici suggérées sont "en principe" seulement, et que leur application dépend des conditions locales
x--x Modifications proposées par George B. Ford, Urbaniste Conseil, délégué par la RENAISSANCE des CITES
Oeuvre d'entr'aide sociale.
23 rue Louis-le-Grand: Paris.

1. *Plans for Reconstruction of Dun sur Meuse, France, Leaving Ruins of Upper Town as They Stand*

provided for large industrial districts along the railroads and the canals radiating from the center of the city and alternating with workingmen's living districts also radiating. An ample playground was attached to every school by appropriating the centers of deep blocks. Parks and connecting boulevards were distributed around the outskirts. Community-center buildings and public markets were located within easy reach. Public and semi-public buildings were given an adequate setting. Many of these ideas and others that we have come to think of as necessities in America were new to them but they are open-minded and want to do the right thing. The city engineers are often the quickest to grasp the new possibilities and the most zealous to push them.

Marseilles and Limoges are wiping out large slum areas and making them into the show quarters of the city.

Lyons, the silk city, has built a great bridge and a big public hospital during the war and is now working on a sewer system and 10,000 workingmen's homes.

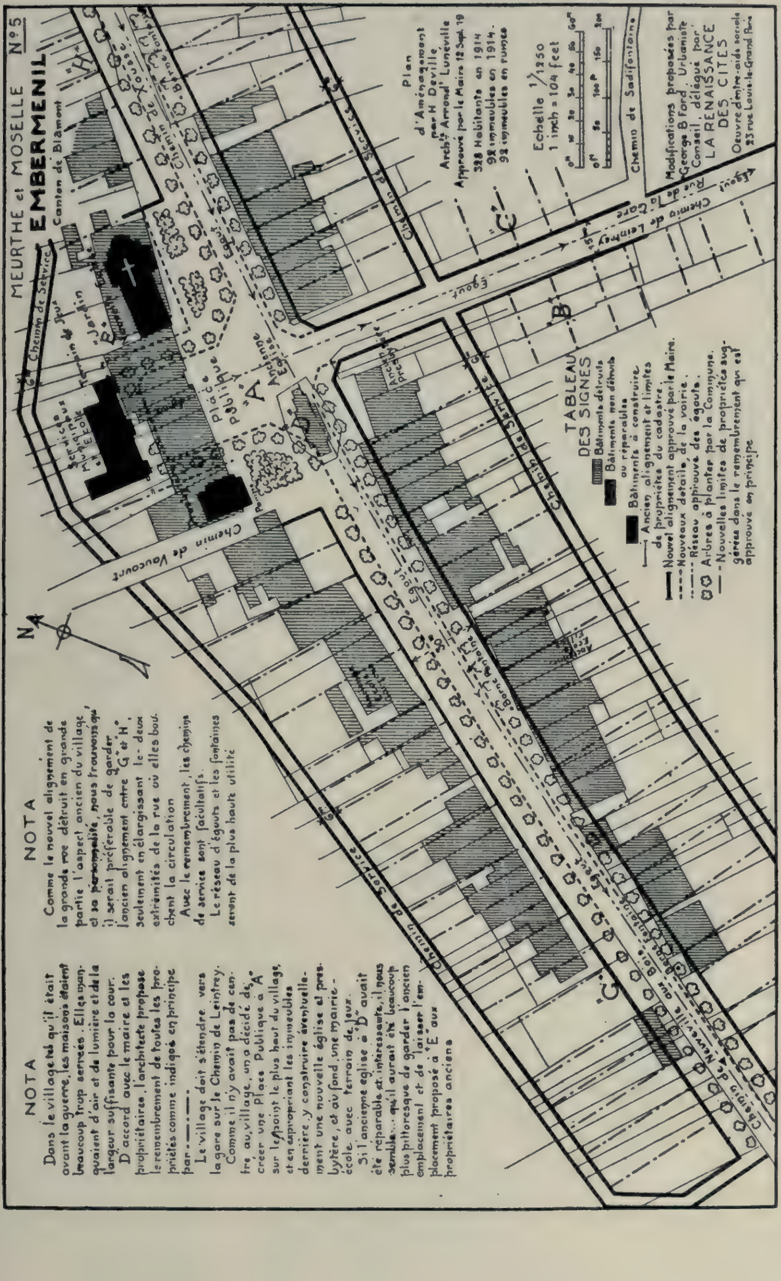
Paris has just held a great competition for a comprehensive city plan for all of the surrounding territory. As a member of the jury, I was most struck by the vision with which the judges approached their problem.

What is there in this record that interests us? First and foremost the great fact that *France, the first of all countries in the world, voted on March 14, 1919, a compulsory city-planning law by which every city over 10,000 inhabitants must make a comprehensive plan for its improvement* and every devastated town and village no matter how small—and there are 2,600 of them—must make a plan for better sanitation, circulation, open spaces, housing, etc., before any permit for any reconstruction can be given.

Already over a thousand towns have their plans and already the State has approved several hundred of them. One and all they are profiting by the occasion to correct the mistakes of the past and to modernize their towns without losing their character, altho I had much ado to persuade some of them not to adopt our nightmare American gridiron plan, which so rubber stamps our towns.

Then they have excellent expropriation laws. It was just five days before the armistice that they adopted a most useful excess-condemnation law; but for years their laws have permitted them to lay out streets on the map in the bed of which the owner can build only at his own risk and the city assesses benefits and awards damages only when it is ready to expropriate.

Furthermore, for many years they have been widening streets all over France by the same process that has been used in widening Chestnut and Walnut streets in Philadelphia, that is by striking a building line a given number of feet back from the old street line and then requiring every property owner on rebuilding to set back to the new line. Fully one-third of the streets of old Paris are being widened to-day by this means. As benefits are assessed at



NOTA

Dans le village tel qu'il était avant la guerre, les maisons étaient beaucoup trop serrées. Elles manquaient d'air et de lumière et de la largeur suffisante pour la cour.

D'accord avec le maire et les propriétaires, l'architecte propose le remembrement de toutes les propriétés comme indiqué en principe par —·—.

Le village doit s'étendre vers la gare sur le Chemin de Leintrey.

Comme il n'y avait pas de centre au village, on a décidé de créer une Place Publique à "A" sur le point le plus haut du village, et en appropriant les immeubles derrière, y construire éventuellement une nouvelle église et presbytère, et au fond, une mairie-école avec terrain de jeux.

Si l'ancienne eglise à "D" avait été réparable et intéressante, il nous semble qu'il aurait été beaucoup plus pittoresque de garder l'ancien emplacement et de laisser l'emplacement proposé à "E" aux propriétaires anciens.

NOTA

Comme le nouvel alignement de la grande rue détruit en grande partie l'aspect ancien du village et sa personnalité, nous trouvons qu'il serait préférable de garder l'ancien alignement entre "G" et "H", seulement en élargissant les deux extrémités de la rue où elles bouchent la circulation.

Avec le remembrement, les chemins de service sont facultatifs.

Le réseau d'égouts et les fontaines seront de la plus haute utilité.

TABLEAU DES SIGNES

- ▥ Bâtiments détruits
- ■ Bâtiments non détruits ou réparables
- ■ Bâtiments à construire
- —·— Ancien alignement et limites de propriétés du cadastre
- ━ Nouvel alignement approuvé par le Maire
- - - - Nouveaux détails de la voirie
- ······ Réseau approuvé des égouts
- ✿✿ Arbres à planter par la Commune
- —·— Nouvelles limites de propriétés suggérées dans le remembrement qui est approuvé en principe

Plan d'Aménagement par H Deville Archt Arrondt Lunéville
Approuvé par le Maire 12 Sept 19
328 Habitants en 1914
98 immeubles en 1914
92 immeubles en ruines

Echelle 1/1250
1 inch = 104 feet

Modifications proposées par George B Ford, Urbaniste Conseil, délégué par
LA RENAISSANCE DES CITES
Oeuvre d'entr'aide sociale
23 rue Louis-le-Grand Paris

2. *Plan for Reconstruction of Embermenil, France. Practically Complete Destruction Permits Modernizing and Beautifying*

the same time damages are awarded, the city, in the long run, secures the widening for a very small outlay.

In 1902, France passed an excellent permissive health-law giving cities the right to appoint health boards and to adopt sanitary codes for which the Government furnished a model form. The famous war-damage act, by which the Government pays all war-damage in full, also provides that all devastated towns and villages must be made more sanitary and that the government will pay a large part of the cost. The result is that water- and sewer-systems are appearing all over northern France.

On workingmen's housing the French Government has been loaning money for many years at two percent interest amortizable in not over 25 years. They loan it to a city bureau or to a housing company on condition that they do not charge over 400 to 936 francs rent, depending on the location and the size of the suite and in no case more than 4¾ percent of the cost of land and building. The government lends from 60 to 80 percent of the total cost and private capital invested in the balance must not pay over four percent. The tenant pays from 2¼ to 3½ percent per annum where he rents and 1/5 down and from 2 to 2½ percent per annum where he buys. Taxes on new housing are remitted for 12 years. Special inducements are given to the needy, to large families, and for the purchase of small farms.

A new bill now before the French parliament provides that the Government shall give outright one-half of the cost of land and buildings with a view to the erection of 500,000 workingmen's homes in the next ten years.

The French have always been famous for their roads, mostly macadam with a very thin top crust. They have stood the inevitable neglect of the war remarkably well. Everywhere in the devastated region they are being rebuilt. They rarely use our tar binders and our oils but they are beginning to use our concrete roads. In Paris, everywhere except on the hills, they are using wood blocks.

Their canals and railroads in the devastated regions have come back with astounding rapidity, but their great contribution is their light narrow-gauge railways that ramify all over the country. These use light rails and virtually no grading. They proved of inestimable value during the war.

There were no community centers in France before the war, but today there are at least four national societies organizing them thruout the devastated regions. The idea is taking hold rapidly, often starting as a workingmen's club. They serve as an excellent counteractive for the saloon.

Beauty and charm has always characterized the French towns and villages. They are apt to place that which is offensive to the sight before that which is offensive to the sense of smell or of hearing. They insist that their towns shall be attractive, often invoking the police power to that end. The interesting part of it is that it costs little, if any, more than it would if they didn't insist. They appreciate the fact that attractiveness in their surroundings is an economic asset. It pays.

Finally, to realize their plans the French have developed vastly of late the principle of "co-operation." Over 1,000 reconstruction co-operative societies have been founded in the devastated regions, several villages often combining in one. Each society, aside from encouragement from the Government, profits by all of the savings entailed in having only one architect and one contractor for the whole group, who buy in quantity and ship in quantity, who can organize large shops, burn their own brick and lime and standardize everything that goes into the buildings.

However, the great outstanding contribution of France is the fact that she now realizes that her towns and villages must plan ahead and private property rights must be controlled for the public good. The war has borne in upon her that mistakes of the past must be corrected. She realizes that she owes it to the citizens of the future to plan for them healthy, convenient, comfortable, charming places to live and work in.

THE CONSTRUCTION OF PUBLIC BUILDINGS AND BRIDGES IN ST. LOUIS

By L. R. Bowen, Engineer of Bridges and Buildings

Previous to the adoption in 1914 of the present or "new" charter by the city of St. Louis, the design, construction and maintenance of its public buildings was assigned to one of the five departments, the heads of which comprised the Board of Public Improvements of the city of St. Louis, while the design, construction and maintenance of the city's highway bridges was assigned to another department under that board. As the department having charge of the construction of new buildings was not properly organized to design the larger public structures, its functions as to new work were limited to the design of the smaller public buildings and the supervision of the construction of the larger public buildings from plans prepared by outside architects. The bridge department, on the other hand, altho it designed all of the city's highway bridges, either suffered from lack of proper architectural advice in its work or was compelled to seek assistance from outside architects.

The new charter referred to above became effective August 29, 1914. It provided, among other things, for a Board of Public Service of five members, in place of the old Board of Public Improvements, and gave to the new board much more extensive duties and powers. In one of the departments of the new board, that of the President, it concentrated the design and supervision of all public work, limiting the other departments of the board, with some exceptions, to the administrative and maintenance functions of the various divisions of municipal work. In this way the bridge and building divisions became placed in one department. For two years they were maintained as separate organizations, but in the early part of 1917, they were combined to form one organization known as the Division of Bridges and Buildings. The organization was then enlarged and perfected so as to handle the design and construction of all municipal buildings and bridges of every size and character. It was also charged with the preparation of plans for the elimination of grade crossings and the conduct of negotiations with the railroad companies looking to that end.

While the combination of the architectural and structural departments is fairly common among the railroad corporations, it is not very common among municipalities and a description of the organization may, therefore, be interesting to some of the members present.

The Division of Bridges and Buildings is now in charge of a structural engineer. The division is divided into two sections having a common drafting room and office. The architectural section is in charge of a chief Architect who has from four to eight or more assistant architects and draftsmen as the amount of work may require. The structural section is in charge of an Assistant Engineer with five or more assistant engineers and structural draftsmen. There is also a Mechanical Engineer of special training in the mechanical equipment of buildings, and a Designer of Plumbing and Sanitation, who plan and supervise their respective branches of work and report to the head of the Division. A Superintendent of Construction of Buildings with such inspectors as he may require looks after the erection of buildings and he also reports to the head of the division. The individual engineers in charge of bridge construction work in the field likewise report direct to the head of the division.

The combination of the structural and architectural departments has worked out very satisfactorily in St. Louis. It has not only replaced much duplication of forces and effected other economies in operation, but has very materially improved the character of the work done. The separation of repair work from the design and construction department, however, altho it relieves the latter from much small and uninteresting work, is not thought to be an entirely happy innovation, as it requires some duplication of forces and loses to the designing department the lessons taught by the repairs.

The design of municipal buildings involves an intimate study and experience with almost every phase of municipal activity, the scope of which, already most varied and comprehensive, is continually being enlarged. Structures affecting almost every phase of human existence from birth to dissolution are now part of the common equipment of every large, modern city.

Certain general principles or methods of procedure are to be followed in the design of all municipal buildings. First of all there is the necessity of making an intimate study, in conjunction with those who are to administer and operate them, of the exact functions of the proposed structures. A careful examination of existing buildings used for the same purpose, if there are any available, is usually very instructive. If an entirely new institution is proposed there is the question of type of buildings, whether a few very large buildings or a group of smaller ones will best serve the purpose for which they are intended. If the latter type is selected there is the further question of a central or unit heating, cooking and serving plants, for the central plants are by no means sure to be most economical and frequently are not. Careful preliminary plans and estimates should be prepared of the different types of buildings considered, and judgment as to the selection should be based on all of the measurable factors known to have a bearing on the particular problem. And it should be made certain that the decision is based on facts. Only too frequently important decisions are influenced by current premises or opinions that are without foundation.

Economy in operation should be constantly kept in mind and consistently sought for in the design. The tendency to overemphasize the administrative portions of public institutions at the expense of the actual working portions should be guarded against. The aim should be the fullest functioning of the plant provided with the least administration. Economy in construction should be religiously adhered to. Facilities of doubtful value or plant not absolutely required should never be provided. Halls, corridors, and rotundas, so common examples of waste space in public buildings, should be provided only where necessary and of dimensions proportioned to their functions.

Only a few municipal buildings need be of monumental construction but all of them should be of pleasing appearance. This should be secured, not so much by the use of expensive materials, as in propriety of design. Money spent in securing a proper design will produce much more in enduring satisfaction than many times the amount put in costly materials injudiciously arranged.

The amount of service rendered in a given year by the designing forces engaged in building work is not fully measured by the amount of money spent for construction during that year. Many plans and estimates are made, and should be made, of structures that are never built. In fact a careful study will frequently bring out a method of obviating or reducing to a minimum a proposed new construction. During the present year the study of the functioning of a laundry, whose size had apparently become wholly inadequate for the large increase in its work, (to provide for which extensive new construction seemed necessary), developed that by a rearrangement of its units so as to simplify the passage of work thru it, and by the replacement of part of its equipment with more efficient units, ample space could be provided for its effective operation with considerable allowance for future expansion. Again during the present year the construction of a new building of an estimated cost in excess of $250,000.00 to house a certain function of municipal service, the archaic and dilapidated quarters for which had become a municipal disgrace, was obviated by making provision for it in an existing building having modern facilities for a similar function, by adding two stories to the existing building and increasing the size of its facilities. This arrangement will not only cost less than one third of the cost of constructing a separate plant, and have the economy of single administration and maintenance, but will afford a location for the service of special propriety and fitness, and offer certain advantages for technical purposes in connection with its administration, that for a long time had been much desired.

In most of the large cities there are one or two old institutions that like Topsy have "just growed." As additions became necessary they were placed in what, for the moment, seemed the most available places, with a resulting hodge-podge of architecture and arrangement. Frequently quarters intended, when built, to be of

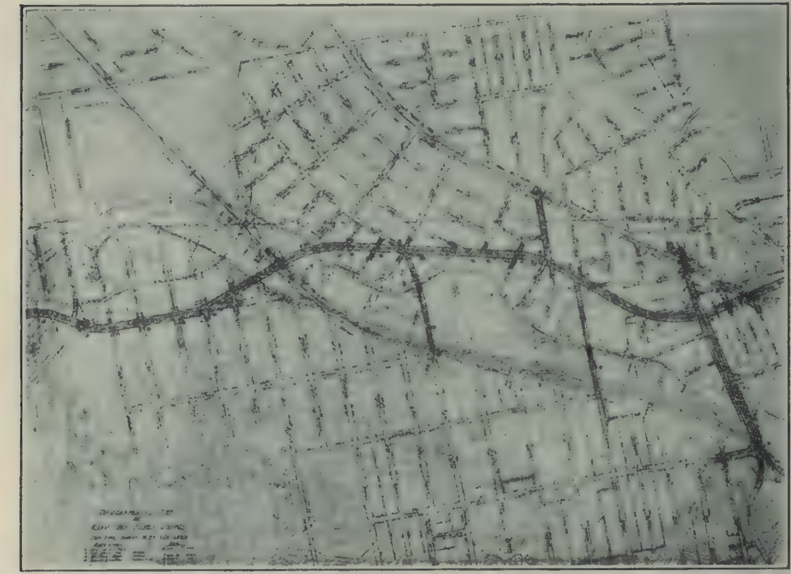
1. *Typical Cottage at Bellefontaine Farms. Each Cottage a Separate and Complete Unit of an Institution Built to a Complete Plan*

2. *Court of Honor for Returning Soldiers. Six Blocks Long. Designed and Built in Eight Days*

only temporary use have been maintained as permanent parts of such institutions. It should be the first duty of the designing forces, when called upon to add to a plant of this kind, to make a survey of the institution and in co-operation with the administering forces prepare and secure the adoption of a general plan for the orderly development of the institution, and for harmonizing the architecture of its units or at least of concealing their most glaring incongruities. The erection of temporary quarters at public institutions should by all means be discouraged.

The design of city bridges differs from that of its buildings in that the structures themselves have fewer varieties of functions.

Most bridges built by municipalities are highway bridges constructed to carry its thorofares across natural or artificial barriers.



3. *Ellendale-Lindenwood Highway and Connecting Viaducts. New Thorofares and Bridges to Connect Areas Separated by Railroad Terminals*

The railroad terminals in the large cities, particularly those, like St. Louis, whose topography has caused them to be concentrated in the valleys, divide the cities into sections as effectively as rivers, bays, or other geographical barriers. Such obstructions, whether bodies of water, steep hills or railroad terminals, prevent a natural and uniform development of a city and restrict its expansion to certain districts at the expense of other parts of the city. The necessity of providing adequate and unobstructed thorofares across these barriers at frequent intervals to give freedom of intercourse between the different parts of the City is imperative. Where at least a few of such thorofares have not been provided very early in the city's growth, it will be noted that the streets of the least accessible of the districts are usually laid out without any reference to those of the rest of the city, requiring the opening thru them, usually at much expense, of new highways to connect their disjointed street systems with those of the city at large.

The determination of the location, grade, elevation and extent of the viaducts or subways necessary to provide thorofares across the barriers, and particularly those required for the elimination of grade crossings, are problems in city planning the solution of which will most vitally affect a city's possibilities for growth and beauty and should receive the most careful study and consideration before a general plan is adopted. As regards the last mentioned phase of this problem, it is desired to give voice to the conviction that the taking away from the large municipalities of the right to determine the methods of effecting the separation of their grade-crossings, and the lodgment of that power exclusively in the hands of state commissions, frequently without knowledge of, or sympathy with the city's problems and aspirations, is a manifest injustice to the large cities. If the states fear that injustice may be done the railroads by the cities, let them determine, by general laws, the proportionate amounts of the cost of grade-separation work to be borne by the respective parties in interest, but let them leave exclusively to the cities themselves the determination of the methods by which it is to be effected, limited as they always are by the requirement that the method adopted be practical and reasonable.

The highway bridges in St. Louis consist principally of bridges over the River des Peres and bridges built to separate grade crossings. The latter are the larger and more numerous and comprise all of the principal viaducts in the city. With very few exceptions all of the large highway bridges have been built by the city, some at the entire expense of the city, but mostly at the joint expense of the city and the railroad companies.

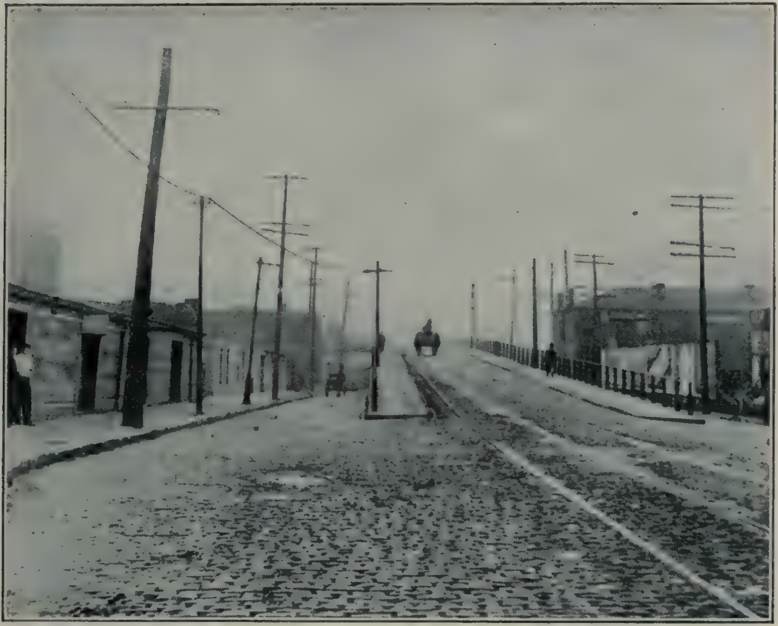
Bridges built to separate grade-crossings present many unique problems. Those affecting the railroad companies of course are worked out in conjunction with their engineers. As the property adjacent to the crossings is usually built up with substantial structures, generally the plants of industries requiring railroad service, the relation of the proposed structure to the adjacent property becomes a very important consideration, as the effect of its construction on such properties, in damages or benefits, may amount to as much or more than the entire cost of the construction itself. In any consideration of this element of the problem, however, the importance of the highway to be served and the paramount interest of the public, in its full and unhampered use, should be kept constantly in mind. By a careful study of the problems of each of the industries affected, undertaken in a spirit of earnest co-operation, which will usually be met with the same spirit on the part of the industry, a plan can usually be evolved that will provide for the fullest use of the highway with the least damage to the industry. But such a study should always be begun with the ideal plan for the street as the end to be worked for and it is surprising how easily the majority of situations will be found susceptible of adjustment to that plan.

Low grades on the viaducts in St. Louis have been adopted even at the expense of heavy damages, for the bridges are permanent structures and the grades once fixed are almost impossible to ever change. No grades for bridges on important highways in excess of 3½ per cent are ever used and in the majority of cases are limited to 2½ per cent. These low grades facilitate the construction of buildings that front along the decks of the bridges and help to give a more pleasing appearance to the structures themselves.

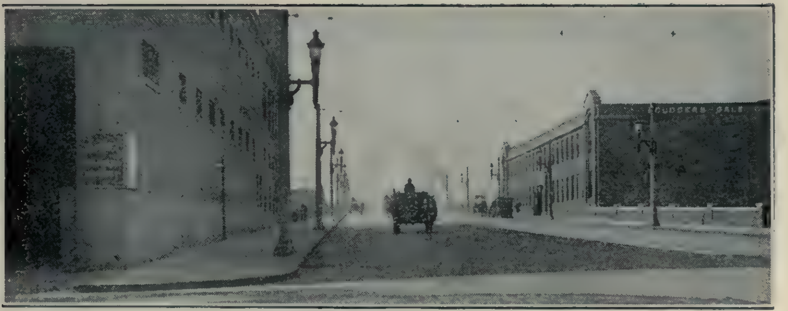
All new highway bridges in St. Louis are now built of reinforced concrete and all are designed to carry street cars. Good bearing soil is the general rule in St. Louis, except along the old creek valleys, where the sinking of narrow concrete shafts to solid rock, (unless quicksand is encountered) is found to be more economical than the driving of piles. The necessity of reducing the thickness of the deck to a minimum in order to secure the best grades with a minimum damage to adjacent property, has dictated the short-span type of viaduct with narrow piers placed between the railroad tracks and with decks of beam-and-slab or solid continuous-slab construction. Except in the parks few opportunities for arch-type bridges are presented.

The tops of the concrete slabs of all of our bridges are made flat across the entire width of the cross-section, the crown of the roadway and the elevation of the sidewalks being secured by building the curbs, roadway foundation and sidewalks upon the concrete deck. While this adds materially to the dead weight of the bridge it has several advantages to wit: It facilitates the construction of the bridge; materially simplifies the laying and repairing of the street-car tracks, as the crown of the finished pavement is 12 inches above the deck slab, which permits the laying of standard track section with steel ties; allows space for the return cables for the street railway company; permits the use of granite curbing along the roadway; allows space under the sidewalks for the great number of ducts, mains, and conduits of the various public service corporations and makes possible the better construction and easier repair of the sidewalks.

As the deck is practically the only part of the average city bridge that is seen by the public, most effort for its ornamentation is spent upon that portion of the structure. Generally all overhead wires except the trolley wires and feeders of the street-railway company are required to be taken down and put in conduits under the sidewalks of the bridge. Combination lamp and trolley poles of ornamental reinforced concrete with lamps and all fixtures and connections constructed of solid cast bronze are placed along the curbs



4. *Twelfth Street, South from Spruce Street, Before New Viaduct Was Built*

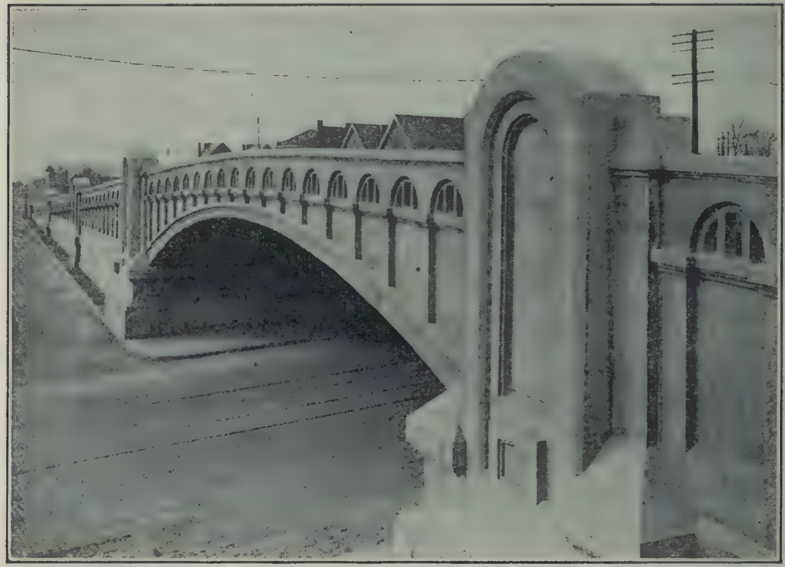


5. *New Twelfth Street Viaduct, One Year Old. Note Improvement in the Abutting Property over Condition Shown in Plate 4*

for the entire length of the structure. Where overhead feeders for the street railway are permitted, their number is reduced to not more than six, and one-half of these are supported along each side of the bridge by bronze fixtures attached to the tops of the concrete trolley- and lamp-posts.

Attractive hand-rails are found to be most difficult to secure and the construction of buildings that abut along the viaducts adds to this difficulty. Designs of hand rails of various materials, of stone, brick, terra cotta, etc., along or in combination with concrete have been tried with varying degree of success.

Much attention is paid to the lines of blocking in the sidewalks, which add or detract materially from the general appearance. It is probable that sidewalks of bridges may offer a field for mosaic patterns of black and white tiles, altho they have never been tried on bridge work in this city.



6. *Bellerive Park Bridge Carrying Boulevard over Heavy-Traffic Street with Car Lines*

In conclusion it may be stated that the making of a proper design is not the whole service of planning, for as every one here knows, there is the other necessity of having it accepted and brought to execution. This requires the exercise of much tact not the least of which comprises

1. The not too great fondness or bias for one's own ideas.

2. The willingness to accept and properly evaluate criticism from every source.

3. The willingness to share credit for an achievement with any one who desires to claim it.

HOUSING

By Nelson Cunliff, Secretary and Manager, Home and Housing Association, St. Louis, Mo.

St. Louis has housing conditions as good and as bad as any of the other cities in the United States. We have shown you our better residence districts but have withheld from you our congested districts in which people are living in crowded tenements and old homes that are vile, filthy and unsanitary. These conditions of which I speak are emphasized as being no worse than in the city in which you live. We have one district in St. Louis in which there are approximately 375 people per acre living in crowded tenements. The old-style homes in St. Louis are undergoing rearrangements such as they were never intended for. The old-time mansions containing ten, twelve, fourteen and fifteen rooms have been converted into boarding and rooming houses. Last week I went into some of these homes, and I have in mind now one of them on one of our principal thorofares in which there are fourteen rooms and I found that twelve families lived in this fourteen-room house. Four or five of these families had two children or more. This house is typical of a row of eight in this particular group and of many other of our old homes that were at one time considered residences of our first families. Conditions in these homes are unspeakable. In a well arranged house there may be a toilet on each floor, which is in a more or less dilapidated condition, and in those houses which may be above the average, running water may be had and a washstand, but seldom is a tub available. St. Louis has been fortunate in one way in having these houses, because it has been thru this means that we have been able to take care of the great influx and increase in population of which we have boasted so proudly.

St. Louis is even now having a steady increase in population. Out of 25,000 emigrants who land in New York city every week, every Wabash train from Detroit usually has a carload of these new Americans who land in our city and make this their home. St. Louis on account of its wide diversity of industries is steadily drawing more people to St. Louis, and these new St. Louisans have been forced to go into homes that were already crowded. This has helped to increase our housing difficulties and has boosted our rents in proportion.

A nice one-room efficiency apartment brings $125.00 a month in St. Louis today; a two-room efficiency, $275.00. This type of apartments and the few houses the Association I represent have built are to my knowledge the only places that are vacant and available in this city.

In June of this year there were 1515 marriage licenses taken out at our City Hall, and a proportionate number for every other month of this year. Where do all of these people go? Where do all of these newly married couples establish their homes? As far as I can find out it is a continued process of doubling up. A few days ago three young men came into my office together asking what could be done towards relieving their situation. On investigation I found that these three young men had married during the past year and the three couples were living together occupying one four-room apartment. Bear in mind, if you will, that here in this apartment of which I speak, there were three potential bosses running that home. Imagine if you will, the length of time that three heads on the feminine side of the family will continue to run in peace and quietude in any single 5 by 7 kitchen. Conditions like this will tend and are tending towards increasing the difficulties in our divorce courts. These conditions also bring about unspeakable moral conditions.

Since the first of May this year our Building Commissioner's office reports permits taken out for 128 family dwellings. Of these 128 permits, 88 were taken out by the Home and Housing Association of St. Louis.

The Home and Housing Association was formed by the Chamber of Commerce and Commercial Club for the purpose of erecting homes and selling them at cost. Our plan is to erect a four, five or six-room house in a desirable location and sell it to the purchaser for 10% cash and the balance in monthly payments over a period of ten, twelve or fifteen years. Our average price for a five-room brick house with slate roof, hardwood floors, hot-air heat, on 30 feet of ground in front of a paved street, is from $7,200 to $7,800. On say a $7,500 house a purchaser is required to pay down 10% cash or $750.00, and then if he so desires he may put his payments on a fifteen-year plan, which will allow him to make monthly payments at $57.00 per month, which price also includes an insurance policy on the life of the purchaser and should he die or become totally incapacitated, his indebtedness becomes fully paid up and the property goes to his estate without any further payments.

Since the first of April we have started 122 houses within the City and County of St. Louis. Eighteen of these houses have been sold and there are now available and ready for people to move into and occupy at least forty new homes. We are finishing new houses at the rate of one per day. The big difficulty that we seem to be meeting in making sales at this time is the fact that few people seem to have the $600 or $700 which is required for a cash payment. Two days ago a man came in and told me that he could afford to make payments up to $100 per month on a house but that he did not have and could find no way of obtaining the necessary $700 with which to make his initial payment. The trouble seems to be that most of our people are living at such high speed, paying such high rents for their homes or apartments, that they have not been able to accumulate the small sum that might be needed for these initial payments. The purchasers find no fault with our homes and we would find a ready response were we to grant them smaller initial payments, but when it comes to responsibility of home-ownership there seems to be a reluctance towards buckling down and assuming this responsibility. In spite of this we are selling from two to three houses per week, and I believe we are fulfilling one of the greatest needs in St. Louis.

If the housing problem is to be met and solved, it will not be done as they have experimented in New York, by regulating rents and curtailing powers and prerogatives of the owners of property, but

First, it can only be met by extending direct encouragement towards the building of more homes. A campaign of education must be inaugurated which will teach the people of our country the necessity of home-ownership.

Second, a revision of building codes will encourage more modern methods of construction and provide for the use of materials and methods that will reduce building costs.

Third, The exemption from both state and municipal taxation of new homes costing $10,000 or less for a period of not greater than five years.

Fourth, The exemption from taxation of all mortgages on homes costing less than a specified sum, say $20,000 as a limit, and

Fifth, By the adoption of a mortgage-recording act.

These I consider the most important of home-ownership propaganda.

Home-ownership in the United States has decreased from 47% in 1890 to less than 40% today.

REPORT OF COMMITTEE ON TRAFFIC AND TRANSPORTATION

Your Committee on Traffic and Transportation herewith respectfully presents its 1920 Report.

The title of the committee indicates that all matters pertaining to traffic and transportation which affect municipal improvements come within the scope of its activities, hence, the committee should in its reports treat of the several methods of transportation utilizing waterways, railways, highways, and airways.

It is apparent that many municipal improvements, such as city and town plans, street systems, individual streets, bridges, terminals and docks are vitally affected by the development of waterway, railway and highway transport and the regulation of traffic on these avenues of commerce.

While this report will be devoted to certain details pertaining to transportation and regulation of traffic on streets, it is well at this time to have a birds'-eye view of the interrelationship of highway, railway, and waterway transport. The phenomenal development of motor-transport on highways is revolutionizing the fundamental precepts of this interrelationship and hence there are many variable factors which require thoro consideration before the economics of this relationship can be established. A committee on this subject presented its first report to the 1920 convention of the National Highway Traffic Association. The following excerpts from this report will give a general view of the present status of this interrelationship:

I. Water transportation, not only along the coast and Great Lakes, but on such rivers as the Mississippi, Missouri, Ohio and many of the southern rivers, has undoubtedly a great future and should be developed far more than has been done in the past.

II. Railway transportation for long-distance business and for all carload business where there is direct track connection to the factory or warehouse of the shipper is and always will be more economical than any form of highway traffic.

III. Highway transportation should be built up and encouraged as supplementary to railway and water transportation.

(a) The motor-truck is the inevitable solution of the railways terminal problem. The most serious expense connected with rail transportation is the terminal expense. From warehouse or factory to cars and from cars to consumer, involving in the case of a large volume of the business two extra handlings of all goods and two short hauls, forms an expense-item equal to the cost of hauling hundreds of miles by rail. We have no definite statistics on this subject. The railroad keeps no record of it. Too often shipper and consumer keep none.

(b) The motor-truck and the automobile extend the zone of territory tributary to the railroads. With the improvement of roads radiating out from railway stations, the use of motors, either on regular routes, or privately owned by farmers and shippers, will place the man who is twenty miles away in as good position as was the man who under old conditions lived four or five miles away.

(c) In metropolitan districts the motor truck has a great advantage over the railroad in quickness of delivery, and probably economy, on hauls of packages and less than carload freight on distances of twenty to seventy or eighty miles. Here the cost of motor-transport has to compete with the cost of transfer at each end of the line, the extra handling and the cheaper per-ton-mile cost of the railroad.

(d) The question of the establishment of lines of motor-trucks in competition with railways is one calling for study. It must be clear that local business on a great thru railroad from such cities as New York, Chicago, Philadelphia, Detroit or Cleveland to towns twenty to forty miles away may get thru occasionally in one to two days, but is more likely to be from four to six days between shipper and buyer, while with motor-trucks it can be delivered the day it is shipped.

Your committee submits for your consideration the following conclusions and recommendations pertaining to several more or less unrelated subjects which come within the scope of highway transport and traffic regulations.

The regulation of traffic affects highway design, construction and maintenance in many ways. It is apparent that efficient regulation will permit the expediting of transportation on highways, which means an increase in the traffic-capacity of streets. Traffic on streets is controlled thru the enforcement of traffic regulations and the utilization of policemen, traffic signs and lights, traffic-limit lines, bumpers or mushrooms, semaphores, crowsnests and "dummy cops." Of these accessories used for the control of traffic, attention is called to one type which is used within the traveled way, namely, the dummy cop, which exists in several forms, but whose primary function is to regulate traffic at street intersections. Generally, a dummy cop is movable and, due to this characteristic, requires consideration on the part of municipal officials. Recently, a case for damages, due to an accident caused by a collision with an overturned dummy cop was brought against the city of New Haven. The assistant corporation counsel states that the court held that the dummy cop was "a proper mode of regulating traffic when in place and in no sense of the word an obstruction." Damages, however, were allowed by the court to the extent of $500 because the accident had occurred due to the collision of the plaintiff's automobile with the traffic-stanchion or dummy cop while it was lying on the traveled portion of the street after it had been knocked over prior to the accident. A canvass of practically all the municipalities represented in this Society indicates that few accident cases have been brought against municipalities in connection with the collision of vehicles with dummy cops and that the use of this form of traffic control is widespread and is serving a useful purpose, especially in a smaller municipalities. It is apparent, however, that movable dummy cops should be so designed and installed that it will be difficult to overturn them as courts will, without doubt, generally rule that while lying in traveled ways they will constitute obstructions in the highway. Without the use of dummy cops many street-intersections would have to be increased in size or their traffic capacity will be reduced and danger of serious accidents will be materially increased.

Your committee recommends that, when three or more streets meet, the intersection be so designed that it will be practicable to instal rotary traffic. This system of traffic control at intersections was originated by William Phelps Eno, and is now used successfully in Paris, New York, Washington, D. C., Detroit and several other cities. If the intersection is properly designed, a vehicle enters the intersection, turns to the right, goes around within the intersection in a circular route until it reaches its desired outlet street. Those who have investigated this system of traffic control at the Place de l'Etoile in Paris and at Columbus Circle in New York, fully appreciate its merit over any other system in use.

A detail of intersection design which must generally be observed at intersections where rotary traffic is installed and which should be universally adopted in order to expedite the passage of traffic at intersections of two streets is the proper design of curb-corners. Investigations show that in many municipalities very small radius curb-corners have been installed. In the days of slow-moving horse-drawn vehicles, the use of short-radius corners was not as objectionable as it is today. In order to provide for expeditious and safe passage of traffic at intersections your committee recommends that generally the proper radius to use is the longest one which may be employed without reducing the width of sidewalks so that they cannot be used satisfactorily by pedestrian traffic.

There has developed, in many municipalities, the use of traffic-limit lines to designate safety-zones. Your Committee especially has in mind lines limiting the boundaries of car-stop safety-zones. These limit lines are designated by the use of painted strips on pavement surfaces, by stanchions, by raised wooden or concrete platforms, or by bumpers or mushrooms. It is evident that the utilization of car-stop safety zones materially reduces the width of roadway available for vehicular traffic and therefore their use should be given careful consideration by municipal engineers and officials in connection with the design of street widths and in the formulation of traffic regulations. Your Committee recommends that municipal traffic regulations include provisions which will prohibit vehicles from stopping at curbs to transfer passengers or commodities opposite car-stop safety-zones and a reasonable distance each side thereof. Considering the general use of roadways adjacent to curbs by vehicles stopping for the transfer of passengers or commodities and for ranking and parking purposes, it is evident if the above regulation is put in force that the utilization of car-stop safety-zones will not usually reduce the available width of roadway for moving traffic.

From the standpoint of the requirements of highway transport, your Committee condemns the uneconomic practice of constructing excessively wide paved roadways in small municipalities. Definite recommendations regarding widths are impracticable without thoro investigations of local conditions. Your committee, however, had investigated many cases which are so flagrant that very little investigation is required. The use of a 65-foot brick paved roadway on the principal thru street of a municipality having a population of only 2,400 constitutes a typical example. This practice appears to be very common in many cities thruout the middle western states.

Closely related to the subject of widths of roadways of the principal thru-traffic streets of municipalities is the utilization of by-pass highways both within and without the municipal street system. The object of a by-pass highway is to divert thru traffic from the principal business streets, especially where such streets are used to their capacity-limit by local traffic. This subject was given thoro consideration at the Third International Road Congress held in London in 1913. The following conclusion pertaining to this subject was unanimously adopted by the delegates from all important countries of the World: "As a general principle, it is better that new main roads be constructed to pass outside rather than thru towns, and that, where an existing main road passing thru a town is unsatisfactory for thru traffic, it is often better, in preference to widening an existing narrow main road thru the center of a town, that new roads should be planned according to the principles of the science of town planning." Your committee indorses the conclusion just quoted. While it is true that many American municipalities favor thru traffic utilizing their main business streets from the standpoint of the possibility of securing trade thereby, it is believed that this attitude will not be justifiable in the near future. In the United States, prior to the War, thru traffic consisted primarily of touring cars. The Third International Road Congress, however, had in mind the broad development of highway transport, as in England particularly the main county highways leading into municipalities had been subjected for several years prior to 1913, to various types of commercial highway transport, such as inter-city haulage, long and short haulage of farm products and other commodities, and rural motor express. Municipal authorities, therefore, should not base their decision pertaining to the advantages and disadvantages of by-pass highways upon traffic consisting of touring cars, but should consider the phenomenal development of commercial highway transport which this country is now witnessing and should give special thought to the desirability or undesirability of its business streets carrying in the future an increasing commercial motor-traffic consisting of motor-trucks, tractors and trailers ranging in pay-load capacity from one-half to seven and one-half tons. A canvas of the municipalities represented in the Society indicates that comparatively few cities are considering the utilization of by-pass highways. However, it is found that the following cities have either constructed or are planning by-pass highways: Baltimore, Md.; Binghamton, N. Y.; Buffalo, N. Y.; Columbus, Kan.; Elizabeth N. J.; Houston, Texas; Memphis, Tenn.; Newark, N. J.; Pawtucket, R. I.; Pittsburg, Pa., Plainfield, N. J.; St. Catherines, Ontario; and Syracuse, N. Y.

Municipal engineers and officials are well aware of the intimate relationship between the design of streets and the installation of car tracks therein. The extension of the street railway service presents grave problems in many municipalities, especially in the case of extensions on streets whose roadways were not designed with a view to the installation of car tracks. In the consideration of the extension of transportation services, your Committee recommends that thoro consideration should be given to the utilization of motor-bus routes. Here again, we find that many English municipalities have had motor-bus routes installed for many years and hence it is practicable to secure a large amount of valuable data pertaining to operation from English sources. In this country the development has been slower but we have, at the present time, several notable examples of efficient motor-bus services, among which may be mentioned those of New York City, Newark, and Detroit. A canvas of the municipalities represented by the membership of the Society shows that motor-buses, with seating capacities for ten or more persons, are operating in the following cities: Asheville, N. C.; Austin, Minn.; Baltimore, Md.; Binghamton, N. Y.; Birmingham, Ala.; Bloomfield, N. J.; Cleveland, Ohio; Detroit, Mich.; Elizabeth, N. J.; Elwood, Ind.; Elmira, N. Y.; Kansas City, Mo.; Kingston, N. Y.; LaGrange, Ga.; Lorain, Ohio; Los Angeles, Cal.; Louisville, Ky.; Miami, Fla.; Minneapolis, Minn.; Newark, N. J.; New Britain, Conn.; Newport News, Va.; New York City; Norwood, Mass.; Ottawa, Canada; Pittsburg, Kan.; Pittsburg, Pa.; Plainfield, N. J.; Richmond, Ind.; Rochester, N. Y.; San Antonio, Texas; Wichita, Kan.; Wilkesbarre, Pa.; and Winnipeg, Canada.

Respectfully submitted,
ARTHUR H. BLANCHARD, *Chairman*
ROBERT HOFFMAN
MAJ. FREDERICK A. REIMER

DISCUSSION

MR. BLAIR: May I make just one remark in reference to that paper? I want to call attention to the fact that this committee has considered but one phase of the situation. Whether they felt that it was incumbent upon them to consider the other phases of the question, I do not know, because I do not know what took place in their intimate discussion, out of which comes this report. You all know that he dwelt entirely with the matter of traffic. I believe that in this society and this country is now due the consideration of the economic value of the track itself.

I just want to cite one little thing that came to me within the past year, and I think you will appreciate just what I mean. In a certain county located about fifty-five miles from a live stock market, the farmers divided themselves into two classes, one of which should market their live stock by truck and the other should market their live stock by rail. They found the economic value in marketing their stock by truck to be one dollar per head and by rail to be two dollars per head. At a subsequent meeting, one farmer got up and said, "We have compared the truck utility in its economy with the railway track, and that is as far as we can go, but we have nothing to compare the economic value of the track that was with the track that might be."

Just one other thought, a little criticism on one little point in Professor Blanchard's paper, and that is the width in the smaller towns, of the wide paved roadway. These small towns take great pride in these conveniences.

PROFESSOR BLANCHARD: Mr. President, I rather imagined I would get a rise out of Mr. Blair when I referred to that 65-foot brick roadway. I will refer to very mild examples. There are, in the State of Michigan, municipalities where the roadways are eighty-five feet. It is difficult to justify the economic utilization of a paved roadway of that width when the future traffic for many years does not demand it.

It is, of course, possible to follow the principles of proper city planning, and utilize that width of street, not roadway, by the construction of two paved roadways, with a parkway in the center. This plan could have been adopted in practically every case the committee had in mind. If it is advisable later to increase the roadway width, the parkway could be eliminated and a pavement constructed. By following the experience of municipalities which have adopted such street designs, I believe, in most cases, that the parkway will remain, and that the thru traffic which adds so much to the total traffic on the main thorofare of many small municipalities, will use by-pass highways.

MR. BLAIR: Just one more word. A week ago last Saturday, I was in one of these towns. The roadways around the court house were paved, 85 feet in width, and all the surrounding streets, much wider streets than found in the city of Cleveland or the city of Chicago, were all very well paved, and what was the criticism I heard in that town from the merchants and their country patrons? The streets were not wide enough and automobiles had to stop outside of the town in order for the people to get to the town to a meeting that was being held on that day. There are certain occasions that demand it, and these streets in these smaller towns are going to be widened instead of being made narrower.

RELATION OF THE PROPOSED UNIFORM VEHICLE LAW TO MUNICIPAL TRAFFIC REGULATIONS

By H. G. Shirley, Secretary of National Committee on Highway Traffic

Laws are always drawn to meet a need. Whether this need is one to correct an abuse or to protect individuals and property, it must exist, and be so insistent as to demand public support in the enforcement of any law enacted.

In drawing up the proposed Uniform Vehicle Law a thoro study was made as to just how far this law should go in regulating and controlling traffic in municipalities, it being realized that in the large centers of population a special control of traffic is necessary and should be provided. Therefore only the basic provisions that should govern and control traffic thruout the state were made state-wide. In arriving at these factors that should be made state-wide the Committee carefully considered the effect they would have on the safe and expeditious handling of traffic in all municipalities and towns, and the good that would come from such a general regulation.

We have seen in the earlier days of motor legislation every district, town, municipality, and county specify a certain speed, load, kind of tire, lights, signals, etc. that should be used. Each unit of government having a different requirement thereby formed a hodge-podge conglomeration of laws and ordinances, making it impossible for any individual to operate a vehicle without violating many of their provisions. Under such conditions abuses crept in. Slow rates of speed would be established, and everyone who passed thru the village exceeding this speed would be arrested, heavy costs placed against the operator, and a small fine. The costs were divided between the officer making the arrest and the magistrate and they had very profitable business, whereas the amount going to the town or village was exceedingly small. This abuse alone made it imperative to have a uniform speed thruout the state. Therefore, to properly govern the transportation on the highways and bring it under reasonable control, it was necessary to establish a few fundamental principles that should not be interfered with by city or town ordinance, and that these principles should be recognized by all municipalities, and co-ordinated with such additional regulations as may be necessary.

In drawing the proposed uniform law it was specified that no license fee other than the one paid to the state should be levied against any vehicle with the exception of the property tax placed on all property. The minimum rate of speed was specified for open country, suburban sections, and closely built up sections of cities and towns, giving the municipality the right to increase the speed if it deemed advisable, but under no condition should it be diminished.

A study of the ordinances of the larger centers of population was made and it was found that on certain boulevards a higher rate of speed was allowed than proposed. It was therefore considered advisable to allow cities or towns to establish a rate of speed in excess of that considered safe on narrowed streets under heavy traffic. The provisions proposed to be state-wide are as follows: license fee, signal devices, brakes, load plates, lights, speed, weight, length, width and height. (Length is not supposed to cover motor-driven street-cars.)

The license fees are based on the horse-power plus a charge per one hundred pounds of gross weight of vehicle and load; pneumatic tires on the basis of 50% lower than those of steel.

Every motor-vehicle shall be required to be equipped with a signalling device or suitable horn for producing an abrupt sound as a signal or warning of danger.

Suitable brakes shall be required, two sets operating independently. All vehicles shall be equipped with a load plate, giving the actual weight of vehicle, with equipment and the weight of the seating or loading capacity of such vehicle as specified by the manufacturer.

Lights on all vehicles shall be such as to give sufficient power to enable the operator to proceed with safety to himself and the other users of the highway. Every motor-vehicle shall have mounted on the right and left side of the front a pair of lamps, and if said vehicle is so mechanically constructed, governed or controlled that it cannot exceed a speed of fifteen miles per hour it shall have front lamps capable of furnishing light of sufficient candle-power to render any substantial object clearly discernible on a level highway at least fifty feet directly ahead and at the same time at least seven feet to the right of the axis of such vehicle for a distance of at least twenty-five feet. If said vehicle can exceed a speed of fifteen miles per hour, then it shall have front lamps capable of furnishing light of sufficient candle-power to render any substantial object clearly discernible on a level highway at least two hundred feet directly ahead and at the same time at least seven feet to the right of the axis of such vehicle for a distance of at least one hundred feet; provided that no front lamp capable of furnishing more than four candle-power light shall be used if equipped with a reflector, unless so designed, equipped or mounted that no portion of the beam of light when projected seventy-five feet or more ahead of the lamps shall rise above a plane forty-two inches higher than and parallel with the level surface on which the vehicle stands; and provided, further, that no electric bulb or other lighting device of a greater capacity than thirty-two candle-power shall be used, no matter how the same may be shaded, covered or obscured.

Speed Limits

(a) Vehicles designed for carrying not more than seven passengers.

Maximum weight, including gross weight of vehicle & load	Speed on open country highway	Speed on suburban streets	Speed on urban street
6,000 lb.	30 miles	20 miles	15 miles
(b) Other vehicles, equipped with pneumatic tires.			
6,000 lb.	25 miles	20 miles	15 miles
8,000 “	25 “	20 “	15 “
12,000 “	25 “	20 “	15 “
16,000 “	25 “	20 “	15 “
20,000 “	25 “	20 “	15 “
24,000 “	25 “	20 “	15 “
28,000 “	25 “	20 “	15 “
(c) Vehicles equipped with solid tires.			
4,000 lb.	25 miles	20 miles	15 miles
8,000 “	20 “	18 “	12 “
12,000 “	18 “	15 “	12 “
16,000 “	16 “	15 “	12 “
20,000 “	15 “	15 “	12 “
24,000 “	15 “	15 “	12 “
28,000 “	15 “	15 “	12 “

No vehicle of four wheels or less, whose gross weight, including load, is more than 28,000 pounds; having a greater weight than 22,400 pounds on one axle, and no vehicle having a load of over 800 pounds per inch width of tire upon any wheel concentrated upon the surface of the highway shall be operated on the highways of this state, except by special permit granted.

No vehicle shall be operated on the highways whose length is more than 30 feet and no combination of vehicles coupled together shall be so operated whose total length, including load, shall be greater than eighty-five feet, except by special permit.

No vehicle shall be operated on the highways whose width, including load, is greater than ninety-six inches, except traction engines whose width shall not exceed one hundred and eight inches.

No vehicle shall be operated on the highways whose height is greater than 12 feet 6 inches.

The provisions of license-fee, gross weight, weight per inch width of tire, the maximum speed, length of vehicle, width of vehicle, and height of vehicle, kind of lights, signal devices, tires, and certain simple fundamental rules of the road are made state-wide, but the rules of the road do not interfere with the traffic plans of any city where traffic regulations are provided.

A motor vehicle has flexibility and is capable of carrying loads over large areas. It is not confined to towns or municipalities, and it was necessary to make a few fundamental principles of this law state-wide, so that a driver of a motor-vehicle would know exactly what to do and what was required of him in operating his car over the highways. The main object of drawing this law was not to restrict but to expedite the handling of traffic and for the protection of property and lives of the people. When a driver has become familiar with this law he will be able to operate his vehicle in any town or city without violating any of its provisions, and it will in time become so well known that in the movement of traffic every driver will fall into his proper place, which will expedite the movement of vehicles to a very great extent.

It must be clearly understood that this law is not to supersede or in any way curtail the handling of traffic by traffic officers in large cities. That is a problem of the greatest importance and means much to the economical welfare and progress of such a municipality, but it is very essential that all the people of a state should know the speed allowed thruout the state, character of lights, the signal devices, the requirements as to loads, tires, length, width, and height of vehicles so that a man traveling from one town to another would not violate the common laws that should be known by every driver. This law applies to horse-drawn just as it does to motor-driven vehicles, and its enforcement should be in the hands of the police of the state outside of the municipalities and cities, but within the incorporated areas should be administered by the police of the city.

In drawing the proposed uniform vehicle law the committee kept in mind the necessity of making it as simple as possible, due to having it adopted by the legislatures of the different states, and it was only drawn to meet an emergency for a uniform vehicle law thruout the entire country.

Your Society is in an exceedingly strong position to have this law put on the statute books of the country, and I would like to impress upon you the great importance of working in close co-operation with each other so as to prevent a duplication or conflict of laws.

Just a word as to the amount of money that can be saved by proper regulations and handling of traffic on the highways, that are daily becoming more and more congested. On a highway having three thousand vehicles per day, and we have many having many times this number, if traffic officers are placed at cross traffic points, say four such points within a mile, and at each one of these points one quarter of a minute could be saved making one minute saved at all four points per mile per team: this multiplied by three thousand teams would make per day 3,000 minutes or 50 hours saved per day. At $3.00 per hour this would mean $150.00 per mile per day, plus the saving in time of the occupants, and say each vehicle carried two persons other than the driver, and their time is worth a dollar an hour, would be $100.00 saved in time, making a total saving of $250.00 per day per mile due to proper regulation. And this multiplied by 300 days would give $75,000 per mile per year saved, less the cost of the traffic officers, which would not exceed $15,000 per year, leaving $60,000 per mile per year saved by proper regulations and traffic control. This multiplied by the many important highways we have will give an enormous saving. We are informed that in the city of Chicago alone traffic is only moving about one-third of the time and standing about two-thirds. If by expert handling a small percentage could be added to its moving, many millions of dollars would be saved to the people of Chicago. I am just bringing this to your attention to try to impress on your mind the great saving that is involved in the proper traffic handling rather than looking at it from the restricted viewpoint of regulation and control.

This problem must be studied with a broad vision, and I trust your Society will not confine its efforts to the densely populated sections altogether, but will take a broad vision of the entire problem and go out on the main highways and help to arrive at a solution of the problem that will give protection to the users of the road, the same as is given within the cities.

WIDTH OF ROADWAYS FOR DIFFERENT CLASSES OF STREETS

By Robert Hoffman, Chief Engineer, Cleveland, Ohio

The determination of roadway widths is not a matter susceptible of exact scientific treatment as several rather indeterminate factors enter into it. Doubtless certain rules have been used by some engineers in fixing roadway widths, which, while permitting an appearance of consistency in their work, after all, expressed only their judgment. Under similar conditions other engineers, equally capable, might not have considered such rule applicable, as their judgment of conditions differed.

The subject of roadway widths has been widely discussed and quite fully treated by roadway engineers and by writers on municipal matters. Not much that is new can be added, yet a review of the situation is doubtless warranted, especially as affected by the motor-driven vehicle. There seems to exist, moreover, a demand for the standardization or classification of roadway widths, so that when certain conditions are assumed the width will be directly determined. This would, in a large way, make possible true economical roadway construction. Economy may be fostered by preventing the building of roadways of excess widths, thereby saving construction cost, and also in assuring paved ways of ample widths, so as to prevent untimely reconstruction in order to meet the demands of traffic. Frequently one sees pavements which appear altogether too wide for the traffic using them. If any excuse for the apparent excess width existed it must have been the adoption of some arbitrary rule fixing the relation between width of roadway and the distance between property lines. Such wide roadways represent an apparently unnecessary and idle investment. The reverse condition, where roadways are too narrow to permit adequate provision for traffic, is also frequently found. This latter condition is specially manifest in roads where street-railway tracks have been laid. Here again the adoption of some arbitrary relation between width of street between property lines and the paved roadway, may have been the cause of building an inadequate roadway, or perhaps the growth of traffic was under-estimated, or the building of the street railway tracks was not contemplated at the time that the pavement was designed. The correction of the difficulty, brought about by providing too small a roadway width, involves reconstruction or widening, generally at largely increased cost, and in addition an untimely hindrance or annoyance to public travel. Extreme foresight in judging traffic conditions and the adoption of some logically thought out standards seem quite necessary in order to prevent the unsatisfactory conditions just mentioned.

The determination of roadway widths may be considered from two different points of view. One is from the viewpoint of appearance, governed by rules of proportion, or by making provision for predetermined widths of sidewalk strips or for lawn and parking spaces. The other viewpoint is that of traffic accommodation.

The first viewpoint applies principally to parkways, boulevards and certain classes of residence streets, where beauty and proportion largely control the design rather than economy and utility. Making the roadway from fifty to sixty percent of the street width between property lines will, in many cases satisfactorily suit conditions. The design of the planting strips and lawns will, however, nearly always control the width and arrangement of the paved roadways. Even here the expected traffic should receive consideration, but its subordination to other conditions may be perfectly logical and free from criticism.

Consideration of roadway widths from the second viewpoint, that of traffic accommodation, obviously applies to the greater number of cases, and should be the prevailing point of view when considering any basis of design or the standardization of widths.

To justify the importance of the subject or roadway widths, it is only necessary to consider the financial side involved. Should the road-building programs, that are now being advocated, be brought to the point of construction, it does not seem impossible that for some time to come ten thousand miles of pavement will be constructed yearly. An extra foot in roadway width involves an expenditure of from two to three thousand dollars per mile of pavement under present conditions. For this country's entire road building project, therefore, a sum of from twenty to thirty million dollars becomes annually involved in the addition or rejection of a single foot of roadway width. This represents waste if the extra foot in width is unnecessary and means ultimate economy, if the additional foot will be required by traffic.

Not only is the unproductive investment, caused by an excessive width of roadway, to be deprecated, but, even more so, if the unnecessary removal of labor and material from useful application elsewhere to be regretted. On the other hand too small a width of roadway may result in slowing down the speed of traffic, in causing accidents due to collision or by vehicles being forced off the pavements and in bringing about a general curtailment of the usefulness of the highway. This condition creates a somewhat intangible damage and monetary loss that may far offset an apparent economy in initial investment.

The amount and character of traffic bear an important relation to the width of a road. The total tonnage for a given time or the weight of individual vehicles are of comparatively little importance when fixing the width, as the controlling factors are the size of the vehicles, the speed with which they are to be driven, and the lateral space which must be provided for passing vehicles.

Passenger vehicles as a class may be assumed to have a maximum overall width of six feet, while trucks and vehicles, normally used for carrying freight or merchandise over highways do not generally exceed eight feet in width. However, there seems to be a natural tendency towards increasing the width of trucks, specially for certain classes of merchandise, which has resulted in a number of places in limiting the size of vehicles by law. So far the maximum width of eight feet seems to satisfy existing conditions. The speed of the vehicles affects the clearance which should be left between vehicles when meeting or passing each other. Obviously fast moving cars require a greater clearance for safety than slow ones. Passenger cars consequently should be provided with greater clearance than slow running trucks. A provision of ten feet in width as the alloted space for each moving vehicle seems adequate for all cases, provided the maximum width of trucks does not exceed eight feet. This unit width is larger than was formerly assumed in roadway design but seems justifiable in the interest of safety. Many country highways, providing for two lines of vehicles, have been built narrower than the ten-foot unit would require, and have served their purpose admirably. Such roadways have been constructed of widths varying from twelve to eighteen feet and when used principally for a moderate number of passenger vehicles have proven quite satisfactory. As the amount of traffic has increased, however, and the number of trucks using the highways has grown, it has been found necessary in many cases to widen the paved roadway in the interests of safety and the expedition of the traffic.

The length of the vehicle as it affects roadway widths is less important except in cases where the use of the vehicle requires its backing to the side of the road in order to load or unload. Many trucks are twenty-five feet in length and become a determining feature if their use necessitates backing up to the curb or the side for the traveled roadway.

The kind of load to be carried may also have an influence on the practical width, as frequently, with light produce or other material, the load is built up so that it extends over the sides of the vehicle. Similarly, occasional loads extend over the back of the vehicle, as in cases of building material. The frequency with which these exceptional cases occur must be considered and may form a determining feature in certain cases.

Should a roadway be restricted for the use of one line of vehicles only, then the ten-foot unit could be somewhat reduced. In such case the width need be only such as would accommodate the wheel-base with a sufficient allowance to cover the irregularities in steering or driving. Probably eight feet in width would suffice. Cases of this kind will seldom occur on public highways and so narrow a roadway would not be justified unless the earth at the side furnished, under normal conditions, a usable road.

On light-traffic roads and where the utmost economy must be practiced, the single-width roadway may be justified, but generally it will be found that the minimum width of paved roadway, acceptable to traffic must provide for two lines of vehicles, and should preferably be built twenty feet in width. Here again this assumption can be modified and the width reduced to as little as sixteen feet when the natural soil conditions are favorable, and admit of an occasional driving off the pavement when forced to do so by some passing vehicle.

For average conditions of traffic, the use of a ten-foot space for each line of moving vehicles, is suggested as a unit of design. This width applies to street-railway cars as well as other motor vehicles. Similarly seven and one-half feet may be assumed as the required space for a row of standing vehicles, as when parked along and parallel with the sides of the road. In fixing roadway widths upon the foregoing basis, the problem lies in assuming the probable number of lines of moving and standing vehicles which must be provided for. Considerable judgment will be required in making such an assumption. The growth of traffic is an element which must be considered and for which no exact data can be obtained. It is well known that the improving of a road by proper alinement, easy grades, and a smooth surface, invites traffic, bringing to such road a far greater number of vehicles that had previously driven over it. With the improvement of the road it will usually be found that new buildings, for homes or industrial uses, will be located along the roadway, bringing with them added traffic in trucks and passenger vehicles. Many occasions will be found for stopping vehicles and allowing them to stand along the way. Should the stopping of vehicles be sufficient to warrant it, an added width must be assumed to provide for the necessary line of standing vehicles. This constantly changing character and extent of use to which a roadway is subject will always make difficult the adoption of the assumption needed for the economical design of roadway width.

In a general way the following classifications may be suggested as a statement of roadway widths in accordance with the foregoing discussion.

(A) *City Streets Having Double Street Car Tracks*

1. Roadway 75 or 80 feet in width. A roadway of such width will accommodate on each half, one line of street cars, two lines of moving traffic and one line of standing vehicles; or one line of street cars and three lines of moving traffic. In the latter case the 80 foot width is preferable. The distance between property lines should be from 106 to 120 feet.

2. Roadway 55 or 60 feet in width. A roadway of such width will accommodate on each half, one line of street cars, one line of moving traffic, and one line of standing vehicles, or one line of street cars and two lines of moving traffic. In the

latter case the 60 foot width is preferable. The distance between property lines should be from 80 to 100 feet.

3. Roadway 40 feet in width. A roadway of such width will accommodate on each half one line of street cars and one line of either moving traffic or standing vehicles. The distance between property lines should be at least 60 feet.

(B) *City Streets Having No Street Car Tracks*

1. Roadway 40, 55 or 60 feet in width. Same condition as for streets having street car tracks, except that line of street cars is replaced by line of moving vehicles. Absence of street car tracks will frequently permit traffic going in one direction to occupy more than half the roadway. This would be possible when traffic is periodically greater in one direction than the other.

3. Roadway 20 to 35 feet in width. Residence Streets. A roadway of such width will accommodate two to four lines of traffic under different combinations of moving and standing vehicles. The distance between property lines should be 40 to 60 feet.

(C) *Highways Outside of Cities*

1. Roadway 40 to 55 feet in width. For traffic between important centers of population. A roadway of such width will accommodate four to six lines of traffic under different combinations of moving and standing vehicles.

2. Roadway 30 to 40 feet in width. For traffic between centers of population of less importance than the foregoing. A roadway of such width will accommodate three or four lines of traffic under different combinations of moving and standing vehicles.

3. Roadway 20 to 30 feet in width. For traffic between cities and smaller places or between important smaller cities. A roadway of such width will accommodate two or three lines of traffic under different combinations of moving and standing vehicles.

4. Roadway 16 to 20 feet in width. Rural Highways. A roadway of such width will accommodate two lines of traffic.

5. Roadways 8 to 10 feet in width. Light country traffic where earth at side can be used to a limited extent.

(D) *Streets in Small Towns and Villages*

1. Same classification as in cities, except that additional width may be required for standing vehicles where business is concentrated on few streets, so as to permit parking perpendicular or at an angle to the curb. Twenty to twenty-five feet for each row of standing vehicles will be desirable in this case.

The foregoing classification must of course be considered somewhat elastic and must be changed accordingly if cars are allowed to park otherwise than parallel with the curb. The question of parking cars upon public streets has an important bearing on the question of roadway widths as it also has upon the control of traffic in general. It must be decided which streets, if any, shall be used for the storage of cars. If the standing of vehicles on the streets is permitted for intervals of possibly longer than an hour, it becomes a problem of storage, and it may be necessary to so design the roadway widths that the greatest number of cars may be accommodated within a limited district. This may require provision for standing cars at an angle to the curb.

The importance of parking regulations entitles it to special consideration and it will not be further touched upon herein, except to note that the adoption of a policy in connection with the parking of vehicles must necessarily have a bearing on the proper widths of roadways.

In conclusion it may be said, that the width of roadways depends upon the size of vehicles, the speed at which they are driven, the lateral clearance between vehicles which should be provided, and the total number which are expected to use the road in a given time, together with their arrangement in lines or rows of traffic. Under average conditions of traffic a width of ten feet may be assumed as satisfactory for each line of moving vehicles, including street cars, and seven and one-half feet for each line of standing vehicles parked parallel with the roadway.

PAVEMENT FOUNDATIONS AS A FACTOR IN ECONOMIC TRANSPORTATION

By Robert C. Barnett, Economic Engineer, Kansas City, Mo.

The purpose of this paper is to trace the connection between pavement foundations and the cost of transportation and to prepare the way for a determination of the critical relation that must obtain in order that such cost may become a minimum.

The ultimate objective is economic transportation.

Pavement foundations are a part of the economic system. To properly correlate the part with the whole and therefore obtain a more complete knowledge of it, it is necessary to have in mind a concept of that whole. Hence, before discussing the part, a bird's eye view, as it were, of the whole system is here presented.

Objective

To produce transportation at the lowest unit cost.

$$\text{Unit cost} = \frac{\text{Annual Cost}}{\text{Annual Ton-mileage}}$$

$$\left.\begin{array}{l}\text{Total}\\ \text{Annual}\\ \text{Cost}\end{array}\right) = \left(\begin{array}{l}\text{Annual}\\ \text{Cost of}\\ \text{Roadbed}\end{array}\right) + \left(\begin{array}{l}\text{Annual}\\ \text{Cost of}\\ \text{Equipment}\end{array}\right) + \left(\begin{array}{l}\text{Annual}\\ \text{Cost of}\\ \text{Power}\end{array}\right)$$

$$\text{Ton-mileage} = \text{Annual tonnage} \times \text{distance hauled}$$

$$T_a = \frac{NKHS}{L}$$

in which

T_a = annual tonnage
N = number of vehicles
K = capacity of vehicle in tons
H = hours of work per annum
S = average speed in miles per hour
L = length of roadway in miles

Characteristics of Roadbed:
Length—Width—Grades—Curvature—Bearing capacity of subgrade

Characteristics of Equipment:
Number of vehicles—Capacity—Weight—Weight of unsprung parts—Resiliency of springs and of tires

Characteristics of Power Plant:
Efficiency of engine and transmission gearing.

Classification of Costs

Annual Cost of Roadbed

1. Interest on construction cost
    1. Land for right of way
    2. Clearing and grubbing
    3. Grading
    4. Paving
    5. Bridges, culverts, and drainage
    6. Fences, signs, markers, safety gates, etc.
    7. Engineering and legal expenses.
2. Maintenance
    1. Repairs
    2. Renewals
3. Administration
4. Amortization

Annual Cost of Equipment

1. Interest on first cost
2. Licenses and taxes
3. Insurance
4. Administration
5. Amortization
6. Maintenance (Repairs and renewals)
7. Garaging

Annual Cost of Power

1. Gasoline
2. Oil, grease and waste
3. Maintenance of power plant (repairs and renewals)
4. Drivers' salaries

Contributing Factors

Fixed Factors

1. Annual Tonnage, net
2. Hours of work per annum
3. Air line distance between termini
4. Difference in altitude of termini
5. Intervening topography
6. Bearing capacity of subgrade

Variable Factors

7. Excess distance
8. Excess lift
9. Resistance of pavement to wear
10. Tractive resistance
11. Loaded capacity of truck
12. Resiliency of tires and springs
13. Speed
14. Efficiency of engine and transmission gearing

Inter-relation Among Factors, or Criteria

1. Economic excess distance
2. Economic excess lift
3. Economic truck capacity
4. Economic resiliency
5. Economic speed
6. Economic tractive resistance
7. Economic resistance of pavement to wear
8. Economic width of pavement
9. Economic cut

These criteria are to be stated in terms of the fixed basic factors.

The foregoing outline indicates that pavement foundations affect the cost of pavements, and that the cost of pavements influences the cost of construction and the interest thereon, which in turn affects the annual cost of roadbed, and thru this the annual cost of transportation. Altho essential to progress, the realization of this sequence of connections is only a bare beginning towards solving the problem of attaining economic transportation. There is further needed a determination of the quantitative effect of one factor upon the other. In the end there must be formulated an expression of the several relations. To develop such an expression, it is necessary to analyze the series of connections in much detail. As a preliminary to this, a brief resumé of the available data is desirable.

First, we have the vehicle at rest with the loaded wheels bearing on comparatively small areas of the road surface, thus producing high unit pressures. This load must be transferred to the sub-grade in such a way that the smaller unit bearing-capacity of the soil will not be exceeded. This transfer is made by the pavement foundation, which undergoes some deformation during the process. This deformation results in varying unit pressure on the subgrade, the greatest being directly under the load and the lesser intensities being at points remote therefrom. The extent of this deformation is affected by the thickness of the foundation. This thickness of foundation affects the unit cost of the pavement, which, as before seen, reacts successively upon the several factors and so influences the final cost of transportation.

Second, we have the vehicle in motion producing an advancing deformation of the foundation simulating a wave action, such that portions before and behind the wheels are slightly raised and negative reactions result. With the frequent recurrence of passing loads, the subgrade recedes a small distance permanently, thus leaving the foundation to span some depression. Then to some extent the foundation functions as a beam. Its ability to do so depends on its moment of resistance, which varies with the square of the thickness. This thickness, as previously noted, affects the cost of transportation. Again, the vehicle in motion on a rough road-surface imparts impact to the pavement which must be ab-

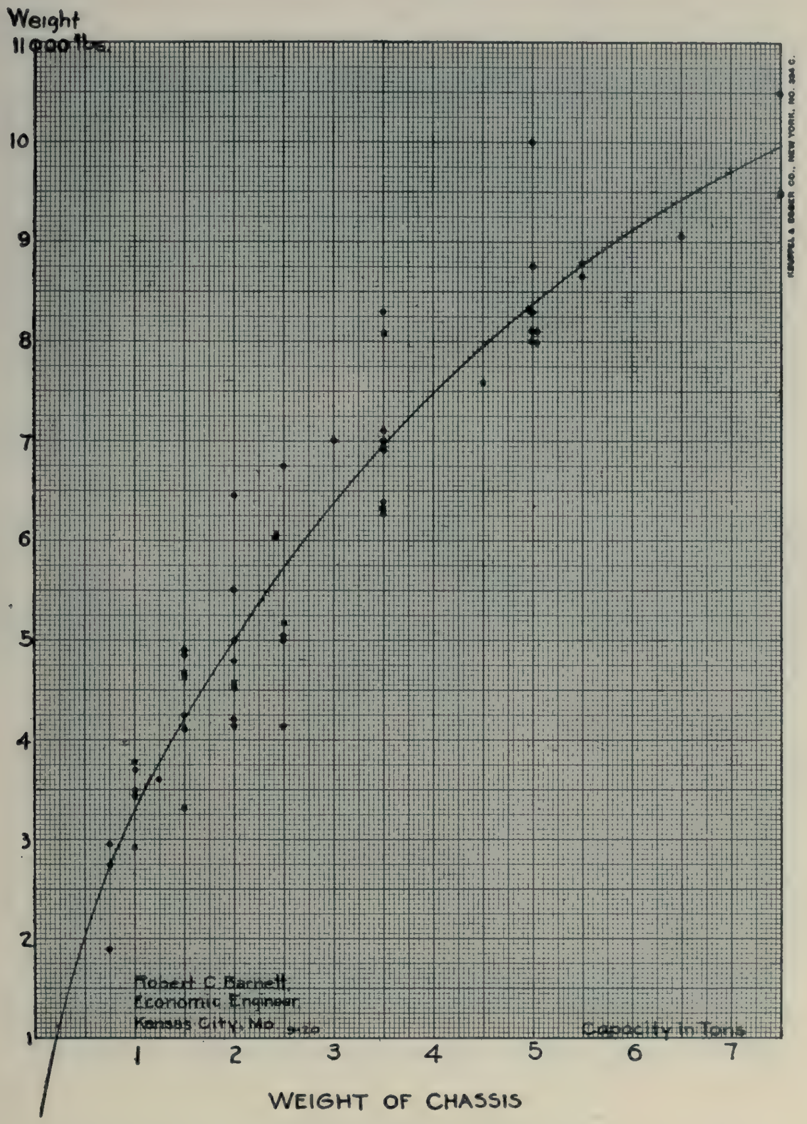
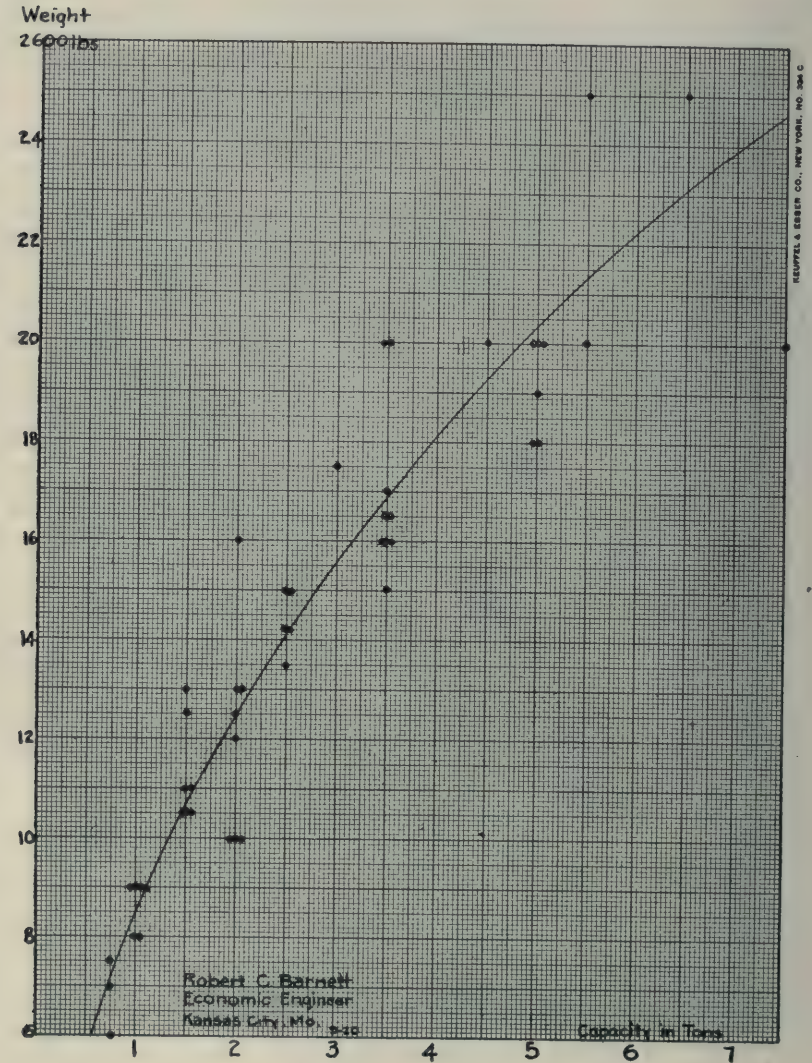

Weight
11000 lbs.
10
9
8
7
6
5
4
3
2
1
1
2
3
4
5
6
7
Robert C. Barnett,
Economic Engineer,
Kansas City, Mo. 3-20
Capacity in Tons
WEIGHT OF CHASSIS
KEUFFEL & ESSER CO., NEW YORK, NO.

Fig. 1



WEIGHT OF TRUCK BODY

Fig. 2

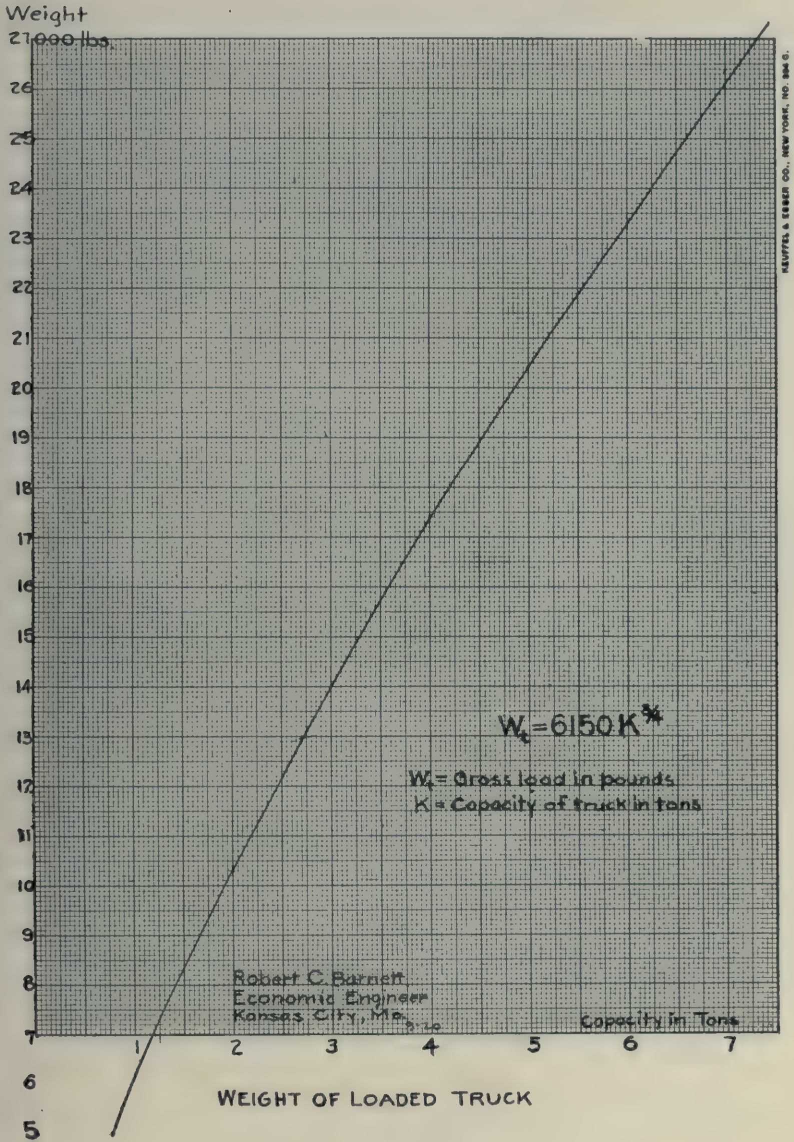
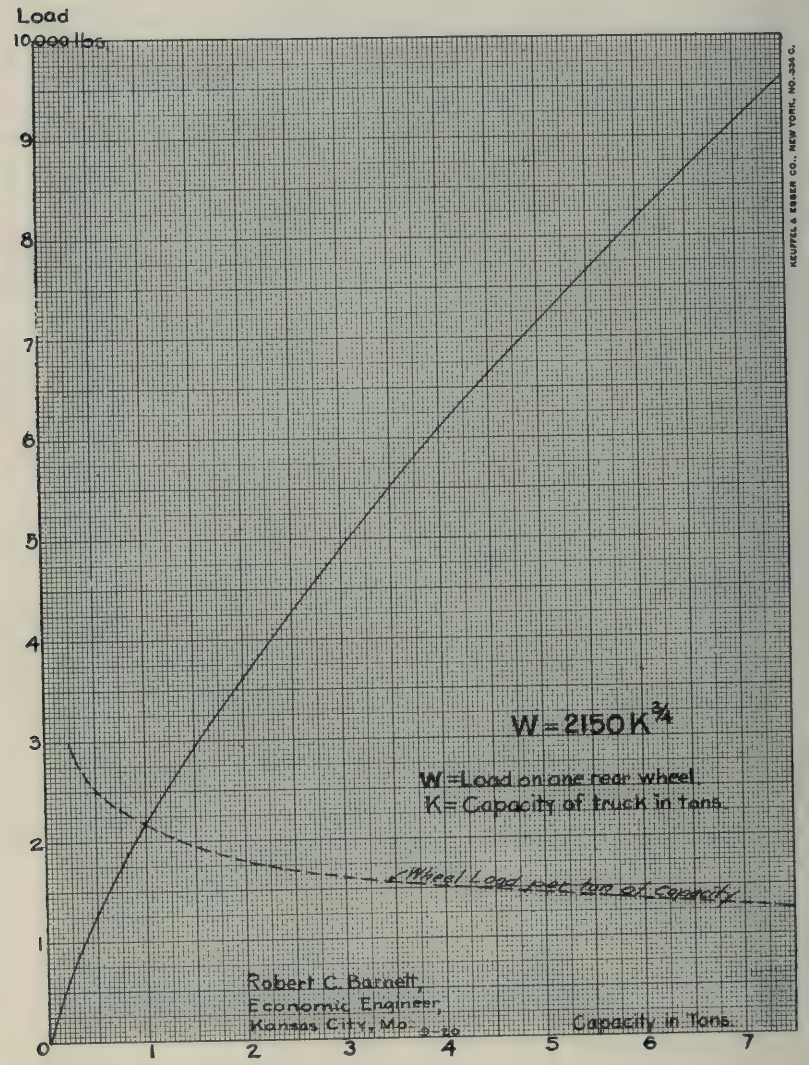
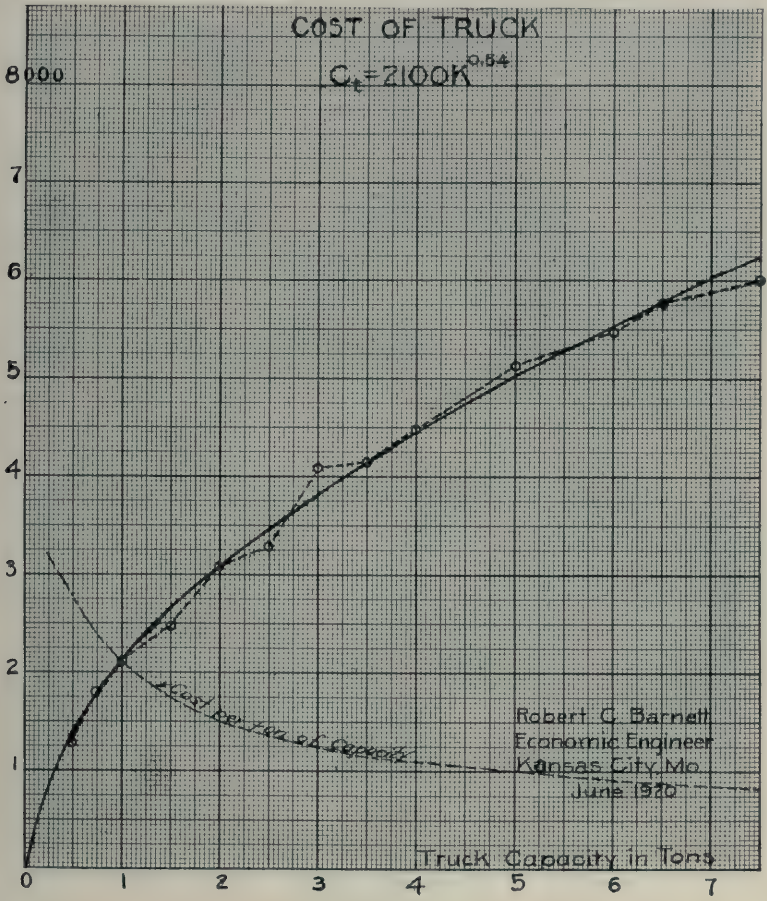

Weight
27,000 lbs.
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
1
2
3
4
5
6
7
$W_t = 6150 K^{3/4}$
W_t = Gross load in pounds
K = Capacity of truck in tons
Robert C. Barnett,
Economic Engineer
Kansas City, Mo. 3-20
Capacity in Tons
WEIGHT OF LOADED TRUCK
KEUFFEL & ESSER CO., NEW YORK, NO. 358-G.

Fig. 3



WHEEL LOAD

Fig. 4



5. *Cost of Truck*

sorbed by the foundation. The ability of the foundation to absorb this energy depends upon its resiliency, which in turn depends upon its elastic properties and upon the volume of the pavement deformed. However, this volume depends upon the thickness of the foundation. As before stated, this thickness affects the cost of transportation.

It is essential, therefore, that we establish an equation expressing the relation between thickness of foundation and wheel load, also another for thickness and impact.

Two general phases are to be considered, viz:

1. The conditions which the structure must meet, and

2. The methods and assumptions to be made in the design of foundations for meeting the imposed conditions.

In order to get consistent and economical results, these said conditions must be standardized.

The standard load to be transferred to the subgrade is the economic wheel load. This is the load on the rear wheel of the economic truck when loaded with its capacity load. The economic truck is one of a group of similar units forming the economic equipment. The economic equipment is that needed for transporting a given annual tonnage over a particular highway in conformity with the economic balance of the contributing factors. The economic balance is that adjustment of contributing factors which produces the minimum cost of transportation.

The standard amount of impact-energy to be allowed for in the design of pavement foundations is such that the cost of an increment to the volume of foundation is equal to the cost of an increment of maintaining the road surface. That is, the lack of maintenance leads to a rough road-surface, which increases the impact and which must be allowed for in the design, or the actual unit stress will exceed the allowable. In other words, it becomes a question of spending money on maintenance or on thicker foundations. The minimum cost is attained when the impact is such that the above mentioned increments balance each other.

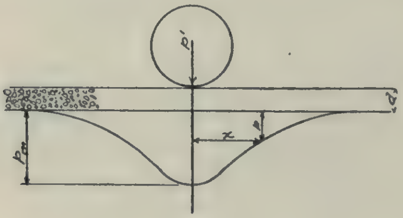


Fig. 6

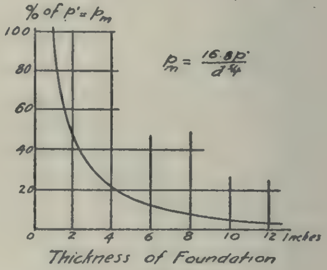


Fig. 7

6. *Relation of Intensity of Pressure and Distance from Load*
7. *Relation of Maximum Intensity of Pressure and Intensity of Load*

It is thus seen that before progress can be made in design, we must be able to assign definite values to the economic wheel-load and to the economic amount of impact.

The economic wheel-load is directly related to the economic truck, which is measured in terms of its capacity-load. From the preceding chart showing items of cost with their contributing factors, it is seen that the factor of load-capacity affects seventeen cost items. This means that in order to determine the economic truck, and thereby the economic wheel-load, we must be able to write the seventeen equations expressing costs in terms of the contributing factors, including load-capacity. The factor of load-capacity would then be treated as a variable, while the other factors would be considered as constants. The part of the total cost affected by load-capacity would be the sum of the seventeen cost items, and such a value of the load-capacity factor would have to be selected as would make this sum a minimum.

Eleven of these seventeen equations can now be formulated with some degree of assurance, but the remaining six involve factors of maintenance for which there are not yet sufficient data available to trace the desired relationship.

As the relations between capacity-load and wheel-load, weight of truck, and cost of truck enter into many of these equations, charts have been prepared to show such functions. (See Figs. 1, 2, 3, 4, and 5.) It should be noted that the unit cost and unit weight decrease as the capacity of the truck increases, indicating that greater economy is to be found in the use of larger trucks if other contributing factors do not conflict.

Passing from the consideration of the physical and economic conditions with the structure must meet, we will next review the methods and assumptions of design.

Two types of foundations are considered: the broken-stone and the slab.

The broken-stone type resists deformation thru the resistance of the particles to sliding upon each other. It is thus able to diffuse the load, or pressure, over an increasing area as the depth increases. It has small ability to function as a beam unless mixed with a binder capable of developing tensil strength, nor can it absorb impact unless the binder has elastic properties. It is essential that the load be distributed over sufficient area by the time it is transmitted to the sub-grade, so that the allowable unit pressure will not be exceeded. The greatest intensity of pressure is directly under the load, diminishing for points remote therefrom. Investigation* shows that this intensity varies as the ordinates of the "probability curve" as defined by the equation

$$p = \frac{p'h}{e^{hx^2}}$$

where

p = intensity of pressure at distance x from the load
p' = intensity of applied load
h = a factor depending upon the depth of sub-grade below top of foundation
e = base of natural system of logarithms = 2.7183.

Experiments on stone ballast indicate that the intensity of pressure directly under the load varies inversely as the five-fourths power of the depth below the top of ballast. Figs. 6 and 7 show the form of these two functions.

It will be seen that for practical purposes a parabola passing thru the apex and the two points of inflection of the curve in Fig. 6 will serve our purpose as well as the original curve. As p would hold for the distance x taken along any line radiating from the wheel load, we would have in effect a paraboloid of revolution representing the upward pressures, or reactions; the sum of which must equal the wheel load. The maximum intensity of pressure is readily found from Fig. 7.

---

* Report of Special Committee on Truck Stresses, Am. Soc. C. E.

The slab-type of foundation is one that can function as a beam. It is able to distribute the load over a larger area for a given thickness of foundation than the broken-stone type, and it can also absorb impact. It undergoes under load a somewhat different deformation than the other type. Investigations* indicate that the elastic curve takes a form shown in Fig. 8. This curve of pressure-intensities is defined by the equation

$$p = \frac{kW}{2e^{kx}} (\cos.\, kx + \sin.\, kx)$$

in which

p = the intensity at any point distance x from load
W = wheel load
e = 2.7183 and
$K = \sqrt[4]{\frac{u}{4EI}}$

u is an elastic constant denoting the pressure per unit length necessary to depress the foundation one unit.

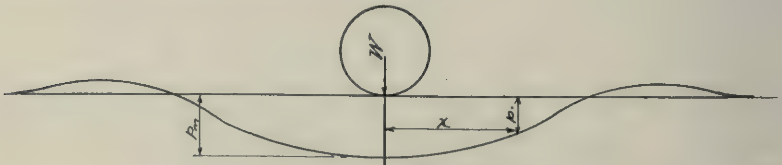


Fig. 8

8. *Elastic Curve Under Wheel Load Impact*

This intensity of pressure, p, would hold for any distance x taken along radial lines and we would have a solid of revolution representing the reactions. In this case we have both positive and negative reactions to consider. As the algebraic sum of these reactions equals the wheel-load, the negative reactions furnished by the weight of the pavement decrease the maximum intensity of the pressure under the wheel-load. This maximum intensity is given by the equation

$$p_m = \frac{kW}{2} = \frac{W}{2} \sqrt[4]{\frac{u}{4EI}}$$

As the moment of inertia, I, varies as the cube of the depth, the intensity of pressure directly under the load varies inversely as the three-fourths power of the thickness of the slab.

As the maximum allowable intensity of pressure may not exceed the bearing capacity of the soil, p_m may be equated to that unit bearing-capacity. Letting B represent this unit bearing-capacity, we can now write two equations connecting thickness of pavement with the wheel load, thus

---

* Report of Special Committee on Truck Stresses, Am. Soc. C. E.

For the broken stone foundation

$$d = \frac{(aW)^{\frac{4}{5}}}{B}$$

a representing the combined constants.

For the slab type

$$d = \frac{(bW)^{\frac{4}{3}}}{B}$$

b representing the combined constants.

It is next necessary to establish a relation between thickness and impact.

First, consider the vehicle at rest. The load deflects the springs a certain distance s. This deflection is proportional to the load W, or nearly so. Next consider the vehicle in motion along a smooth pavement while the original deflection of the springs remains constant. When a depression or a hole is encountered, the support for the wheel is suddenly removed for a brief interval and the spring is left free to produce motion in a vertical plane. The force of the constrained spring reacts against the car-body and pushes the axle and wheels away from the body. This action is independent of any horizontal motion the car may have. We wish to know how much energy is available for vertical impact. This energy is a function of the mass of the unsprung parts and the vertical velocity at the instant of impact. This velocity is obtained from the differential equation for acceleration. The acceleration is proportional to the force acting on the mass of the unsprung parts. This force is in turn proportional to the distance which the loaded car-body has deflected the spring originally, hence the acceleration is proportional to this same distance s. However as the spring regains its unconstrained position, it exert less and less force on the unsprung parts and the acceleration decreases. Letting x equal the amount of deflection at any instant, measured from the neutral position of the spring, we have

$$\text{Acceleration} = \frac{d^2x}{dt^2} = -fx$$

in which f is the force acting at a unit distance on a unit of mass. Integrating this expression, we have

$$\text{Velocity} = \frac{dx}{dt} = \sqrt{f(s^2 - x^2)}$$

Substituting this value in the formula for energy, we have

$$E = \frac{mf(s^2 - x^2)}{2}$$

$s - x$ equals the depth of the hole encountered by the wheel. This depth of hole may be used as an inverse measure of the degree of maintenance.

The ability of the foundation to absorb this amount of energy depends upon its resiliency. For a beam of rectangular section this becomes

$$R = \frac{S^2AL}{18E}$$

in which

S = unit stress
A = area of cross section
L = span
E = modulus of elasticity

This would represent the condition which obtains after the pavement has been in use for some time when the subgrade had receded from a portion of the slab. By equating the resilience to the energy of impact, we get an expression connecting the thickness of foundation to the drop of the wheel when the vehicle passes over a hole or depression. Thus

$$\frac{S^2AL}{18E} = \frac{mf(s^2-x^2)}{2}$$

but the area of a cross section of the foundation is equal to the thickness, *d*, multiplied by the effective width, *b*. Substituting and solving for *d*, we have

$$d = \frac{9Emf(s^2-x^2)}{S^2bL}$$

In this expression *m* and *f* are related to wheel-load. That is, for standardized conditions previously referred to, the mass of the unsprung parts would be a certain percentage of the gross load, as would also the weight resting on the rear springs. The wheel-load is related to the gross load, being approximately thirty-five per cent thereof. The preceding formula can be reduced to the following

$$d = \frac{CW^2(2s-h)h}{S^2bL}$$

in which

C = a constant
W = economic wheel load
s = original deflection of spring
h = depth of hole in pavement which controls the amount of impact

The effect of impact is further modified by the resiliency of the tires, the result being to retard the delivery of energy to the foundation. This would reduce *d* in the above equation. Experiments are needed to determine the extent of this action.

QUANTITATIVE RELATION OF FACTORS TO COST ITEMS

	ANNUAL COST OF TRANSPORTATION	1.Annual Tonnage	2.Hours of Work	3.Air Line Distance	4. Difference in Altitude	5. Intervening Topography	6. Bearing Capacity Subgrade	7. Excess Distance	8. Excess Lift	9. Resistance of Pavement to wear	10 Tractive Resistance	11 Load Capacity	12 Resiliency of tires	13 Speed	14 efficiency of engine
ANNUAL COST OF ROADBED	1.Land for Right of way	✓	✓	✓		✓		✓	✓			✓ε		✓	
	2.Clearing & Grubbing	✓	✓	✓		✓		✓	✓			✓ε		✓	
	3.Grading	✓	✓	✓		✓		✓	✓			✓ε		✓	
	4.Paving	✓	✓	✓			✓	✓			✓	✓ε			
	5.Bridges & Culverts	✓				✓						✓ε	✓	✓	
	6.Fences etc.			✓				✓							
	7.Engineering & Legal			Percentage of cost items one to six											
	8.Maintenance	✓		✓				✓		✓		✓	✓	✓	
	9.Administration			Percentage of Maintenance								✓			
	10 Amortization	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	
Annual COST OF EQUIPMENT	11 Interest on Equipment	✓	✓	✓				✓				✓ε		✓	
	12 Licenses and Taxes	✓		✓				✓		✓		✓	✓	✓	
	13 Insurance			Percentage of Item 11.								✓ε			
	14 Administration											✓ε			
	15 Amortization	✓		✓				✓	✓		✓	✓			
	16 Maintenance	✓		✓				✓	✓		✓	✓			
	17 Garaging											✓ε			
Annual Cost of Power	8 Gasoline	✓		✓	✓			✓	✓		✓	✓			✓
	19 Oil, grease and waste	✓		✓	✓			✓	✓		✓	✓			
	20 Drivers' salaries.	✓	✓	✓				✓				✓ε		✓	

9. *Check Marks Indicate Relationship Between Items*

We have now established the two equations, referred to in the early part of the discussion, connecting thickness of foundation with wheel-load and with impact. Tentative numerical values might now be assigned to the several constants and thus put the formulas in shape for ready application. However, that is beside the object of this paper as set forth in the opening paragraph, and would divert attention and interest from the larger and more important issue, viz. the determination of the critical relation between pavement foundations and the cost of transportation such that a minimum unit cost may result.

The determination of this critical relation hinges upon the determination of the economic wheel-load and the economic amount of impact, which in turn involves data relating to maintenance of road-bed in terms of wheel-load and maintenance of truck equipment in terms of the amount of mechanical work done per annum. Until these data are accumulated, our analysis, in this respect, must remain incomplete and our conclusions be considered as provisional.

In the case of economic wheel-load, some attempts have been made by the author to formulate an expression for the economic criterion. The result was published over a year ago, but is not given here because the subsequent accumulation of data on impact, due to the timely and painstaking investigations of the Bureau of Public Roads, makes revision necessary.

In Recapitulation

It is to be noted that

1. The unit cost of pavement foundations affects the cost of transportation.

2. The unit cost of a foundation depends on the type and on the thickness.

3. Thickness depends upon the wheel-load and upon the amount of impact to be absorbed.

4. Wheel-load is related to the load-capacity of the truck upon which the cost of the truck depends and in its turn the cost of transportation.

5. Impact is related to the weight of the unsprung parts, to the primary deflection of the spring, and to the distance which the wheel is allowed to drop.

6. The weight of the unsprung parts bears a relation to the weight of the truck.

7. The primary deflection of the springs depends upon the weight of the loaded truck.

8. The distance thru which the wheel drops depends upon the depth of the hole in the wearing course of the pavement, which is a measure of the lack of maintenance.

9. The less the maintenance the more the impact and the thicker must be the foundation and consequently the greater the

cost of transportation. On the other hand, the more spent for maintenance the greater the cost of transportation, but this is offset to some degree by a diminished impact and a lesser thickness of pavement and a decreased cost of transportation. There is some combination of these conflicting factors for which a minimum cost occurs.

10. Any specification for design of foundations must define, among other things, the load which the foundation should carry (the economic wheel-load), the amount of impact to be absorbed, the span over which the slab is to act as a beam, and the effective width of such slab.

11. The determination of the economic wheel-load and the economic amount of impact must precede the determination of the economic foundation.

In conclusion it is pertinent to emphasize the fact that the problem of determining the economic foundation is but a detail of a much larger problem, that of determining the economic balance of all the contributing factors, that adjustment which produces the minimum cost of transportation.

REPORT OF THE COMMITTEE ON FIRE PREVENTION

Alcide Chaussé, Montreal, Can., Chairman

Canada, which really started its fire-prevention work only after the United States, or some of them, had been working at it for a score of years, has at one bound passed beyond anything accomplished in the United States in the ways of laws, organization and co-operation. It is too early to say what will be the result, or how soon Canada will surpass the United States in actual prevention of fire waste; but unless the United States and the states thereof wake up, Canada will surpass in the ranks of fire-safe countries while the United States is still struggling with the A B C of the problem.

Canada is doing on a national scale what some American cities have done on a municipal scale; it is interesting its people, in every walk of life, and giving them something to do to meet the burden of their own responsibility for fire. As the result, the hardheaded business men of the Province of Ontario, for instance, supply real money to the fire marshal of that Province in order that he may print hundreds of paid advertisements in Canadian papers to inform the people of the facts involved in fire waste, of methods of fire prevention and to educate them as to their own responsibility.

The Prevention Day activities, in October last year, thruout the United States and Canada bear ample evidence of the fact that Canada has had firm hold on the main factor in the problem. It remains only for the people of the United States to say whether, having originated modern fire-prevention work and laid the foundation for the structure, they shall permit Canada to wrest the lead from them now.

The Ontario Fire Marshal Department projected its work along the most ambitious lines ever formulated by any similar department. Every form of publicity, including extensive advertisements in the leading provincial journals, paid for by the Ontario Fire Prevention League, was used. A series of nine advertisements, dealing with all phases of Fire Prevention Day and directed toward various interests, was used. These advertisements appeared in the dailies of 29th September, 2nd, 3rd, 4th, 7th, 8th and 9th October; in the weeklies for three weeks prior to the 9th October, and in the magazines for various periods, as some were weeklies and some were published only once a month. Editors of all publications did everything possible to co-operate and used much space in their news and editorial columns in behalf of fire-prevention propaganda.

A prospectus for the day was prepared, published and distributed to all schools and principals of schools thruout the

Province, to municipal officials, fire chiefs, members of the Ontario Fire Prevention League, clergy of all denominations, etc., and a booklet "Fire Prevention on the Farm and Elsewhere," was sent to school principals and others.

Ten thousand copies of lithographed Fire Prevention hangers were distributed thruout the Province, chiefly by chiefs of fire departments. Where there were no organized fire departments, heads of municipalities or postmasters made the distribution.

Much interest and enthusiasm was shown among the pupils of the various schools, on account of the distribution of 1,000 medals offered as prizes by the Ontario Fire Prevention League to pupils in third and fourth grades for essays on "Fire Prevention in Home and Factory." In addition, special gold and silver medals were offered for the best essays on the same subject by students in the high schools and colleges.

A municipal fire department is maintained to provide safety against fire loss for life and property in the municipality. That statement should be analyzed carefully by every man in charge of fire control departments. It includes fire extinguishment, fire prevention, protection of goods against water damage incident to fire extinguishment, correct advice on procedure after a fire to avoid contingent fire losses due to exposure of property, competent advice on industrial plant protection and community leadership in everything pertaining to fire control. To put it in another way, the business of the municipal fire department is to reduce the loss of life and property from fire for the citizens of the community. Every avenue of effort which will bring adequate returns to this end should be followed.

The effectiveness of any fire protection appliance frequently may be greatly enhanced by locating it at a strategic point. Every fire inspector who recommends installation of appliances should always point out to the property owner the most effective location for it. The inspector has made a special study of fire hazards and should know where these places are. If the recommendation states only that a fire extinguisher should be placed on the premises, this extinguisher may not be placed where it will most likely be needed or where it can be obtained in the shortest time possible upon discovery of fire. There is a best place for nearly every kind of fire-protection appliance.

When the chief executive of an industrial plant is approached on the subject of fire prevention and fire safety for his buildings, equipment and employes, his first remark is likely to be that he is so busy watching production and distribution problems that he cannot give fire safety any detailed supervision. While the fire-safety of a plant is in reality one of the production problems, since the destruction of the plant means complete cessation of production, nevertheless the executive who makes this objection is telling the real truth. But when he has this same problem to face for his credit department, sales department, advertising department or any other distinctive branch of his business, he immediately seeks to find someone upon whom he can unload the responsibility for the successful conduct of that part of the business. And that is exactly the course which should be pursued in dealing with the problem of fire safety.

The problem of fire safety in American business institutions will be solved when the executives of these institutions recognize fire safety as of sufficient importance to call for centering responsibility for that particular job on some one man's shoulders.

The executives who have made one man in their plant responsible for its fire safety have not added to their burden, they have in reality decreased it for they will have pushed on to another what they have often worried about but never taken action to remedy.

The National Fire Protection Association held its annual convention in May this year at Chicago, and adopted tentatively regulations for the installation and operation of acetylene compressing plants, hazardous chemicals and explosives, fire-pumps and first aid, field practice, inflammable liquids, safety to life, etc. The N.F.P.A. is an organization which works out and stamps with its approval standards governing the installation, operation and maintenance of all kinds of fire appliances, and rules and regulations applying to all methods of fire control with the single exception of fire-department operations. It is this latter work which the International Association of Fire Engineers has undertaken, at its annual convention which was held at Toronto, Ont., recently.

The report of the Proceedings of the Conference on Concrete House Construction, held at Chicago, on the 17th to 19th February last, is most interesting reading for those interested in the construction of fireproof houses. Copies of this report can be had from the Secretary of the National Conference on Concrete House Construction, 111 West Washington Street, Chicago, Ill.

FIRE PREVENTION AND FIRE FIGHTING

By Clarence E. Ridley, New York City

While the doctrine of "Save and Conserve" has been preached from the valley to the house-top the past four or five years, what have we as a great and prosperous nation been doing to put this doctrine into actual practice and make possible the conservation which is a growing necessity in every country of the world today?

Of course, we all agree that it is just plain logic to preach the idea that fire prevention is less costly than, thru carelessness and ignorance, to allow buildings to be consumed in flames, and often, too, it is material that cannot be replaced at any cost, owing to the present market condition.

Shall we continue to exert our greater energies to perfecting equipment and organizations for fire-fighting, and continue to satisfy ourselves by talking much and acting little regarding fire-prevention? Shall we continue to waste millions of dollars monthly by concentrating our greater efforts on fighting the effect rather than on removing the cause? We would as surely fail in trying to solve our problem of lowering fire losses without finding the cause as did the surgeons of old in trying to lower the death-rate from yellow fever in the Canal Zone without first locating the cause. And our efforts will as surely be crowned with success as were the efforts of the late General Gorgas if we will do as he did. He got at the bottom and exterminated the cause, the mosquito.

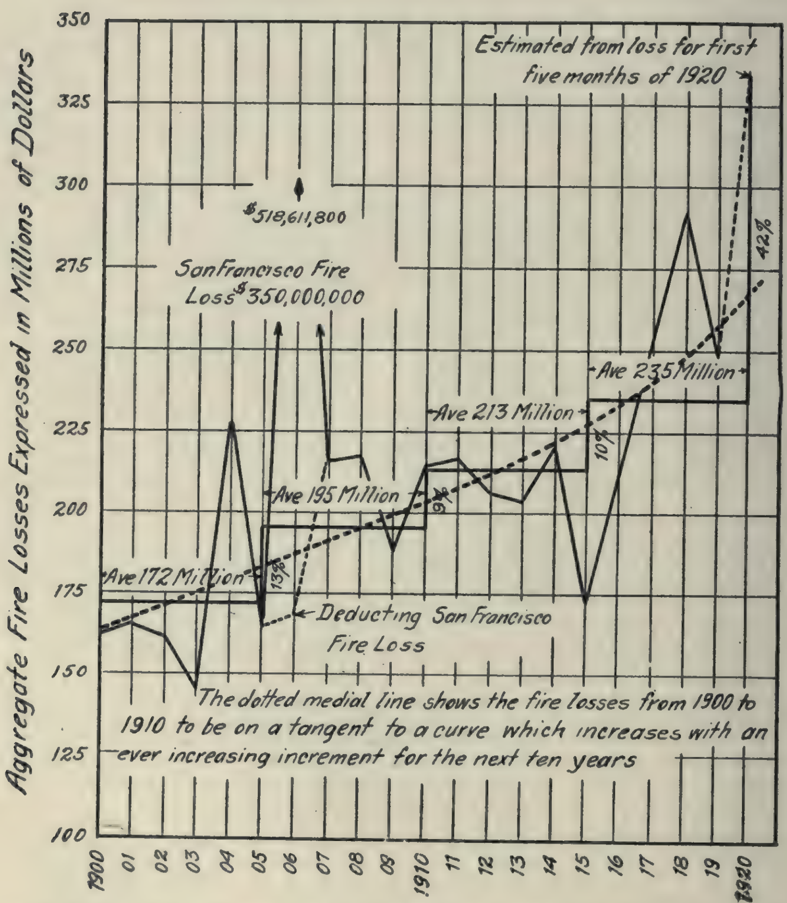
In a similar manner we must believe more, or in fact, practice more the necessity of removing the causes of fires before we can reasonably expect the desired results. Yellow fever cannot be entirely eradicated by exterminating the mosquito, neither can fires be entirely done away with by fighting the causes; but as the yellow fever plague can thus be controlled, so also can the scourge of fire which continues to reap its rich toll each year in ever increasing amounts.

To men interested in the building, maintenance and operation of cities, the following figures cannot help but make an appeal. The information for this table of fire losses was obtained from "Principles and Methods of Municipal Administration" by W. B. Munro, also from "Fire and Water Engineering" and data furnished by the National Board of Fire Underwriters.

Years	Aggregate Loss in Five Year Period	Average Annual Loss
1875–79	$ 353,018,285	$ 70,603,657
1880–84	450,587,163	90,117,432
1885–89	561,959,099	112,391,819
1890–94	711,825,711	142,365,152
1895–99	661,393,958	132,378,791
1900–04	862,325,860	172,465,172
1905–09	1,305,509,159	261,101,831
1910–14	1,062,649,675	212,529,935
1915–19	1,177,456,995	235,491,399

Your attention is also directed to the accompanying diagram showing the fire losses for the past twenty years. These figures are based on insured losses only. The National Board of Fire Underwriters estimates an addition of 25% to cover uninsured property losses. The rapid increase, especially over the last ten years, is appalling to say the least, and how much longer are you and I going to allow each person of this country to lose $2.50 each year thru this channel? Let it be repeated, the amount is lost never to be regained. It is your loss whether you are a policy-holder, a bank-president, a merchant, a barber, or a backwoodsman totally unfamiliar with insurance business. It is your loss and my loss, either directly or indirectly, and therefore, fundamentally we should be interested, and the fact that we are members of this great Society ought to be proof that we are interested.

ANNUAL FIRE LOSSES IN UNITED STATES



These figures carry more significance when compared with the percapita loss in European countries. From Munro again we are attracted to the following fire-losses in the United States and Canada and the principal European countries for the year 1911:

	Losses per Capita
United States and Canada	$2.62
France	.81
England	.53
Italy	.31
Germany	.21

If we had marked improvements since 1911 we could possibly find some satisfaction, but the case is quite the contrary, for in 1919 the aggregate loss amounted to $249,179,275, an increase of 15% over the loss of $217,004,575 recorded in the United States for the year 1911. It is true that the population increased during this period, and true also that valuations have been raised, but hardly in proportion.

Trusting that we have sufficient proof that the pudding is hot without tasting, may we consider a suggested remedy for this apparent and growing calamity. Efficient and far-reaching work has been carried out by various agencies thruout the country in an effort to stem the growing tide of fire-losses by means of prevention, but the results lead us to search into the methods of operation as it affects the municipal authorities. I am wondering if the average city official, for the "average" city official is still in the majority, yet realizes the relative importance of fire-prevention and fire-fighting.

It is not the intention of the writer to minimize the importance of providing for adequate and efficient fire-fighting organizations and equipment, for we all realize that fires are similar to other undesirables, they are always with us and always shall be, but if the municipality can be brought to see the need of adequate supervision and control of its fire-prevention department, a big step forward will be accomplished. If this convention assembled here can take a lead in this move, it will have accomplished a great and glorious task. May the day speedily come in the life of our great American city when a fire of unusual circumstances will arouse the public similar to the interest now manifested in a mysterious death. May that time soon come when similar to the coroner's inquest we shall have a body of men with serious hearts probe the cause of that destructive enemy of progress, fire, and render a decision boldly and without fear or favor. Such a course, I believe, will render an invaluable service to mankind, and we will sooner be able to hold our heads up when statistics of fire losses are being read in our presence.

MUNICIPAL FINANCES

By Louis Nolte, City Controller, St. Louis, Mo.

Municipal finance in the city of St. Louis during the period of the Great War, and continuing to the present day, has been the same difficult problem to solve to a greater or less extent, that our sister cities generally, thruout the country, have been confronted with. St. Louis, however, has been more fortunate, we believe, than most cities of its class, in that it has been able to finance the wants of its numerous departments and activities, and supply money for pressing needed permanent improvements, during a period of unprecedented high wages and salaries and unheard of prices for supplies and materials, out of its annual revenues; finding it unnecessary to resort to sale of bonds or being compelled to call on outside sources to meet its current obligations and expenses. This has been accomplished, too, without increasing our tax-rate for state, school or city purposes, the rate having remained stationary, viz: $2.35 on the $100.00 valuation for the years 1915 to 1919 inclusive.

The loss of revenue from dramshops has affected the city's receipts to the extent of approximately $1,000,000 per year since prohibition became effective. The deprivation of such a sum has been very keenly felt, and has been quite a handicap, particularly during a period such as we now are laboring under. To offset this loss a Committee was appointed last year by the Board of Aldermen, which Committee, working in conjunction with the Department of Finance, has sought to discover new sources of taxation, from which the city may collect additional means to meet the constant expansion of departments and increasing demands for, and up-keep of, new activities that are now-a-days considered a necessary part of the life of urban population, and a legitimate demand on the city's revenues.

Under our laws the city's revenue is divided into three groups, and is set aside and must be kept separate and distinct for the following purposes:

First: Interest and public-debt revenue for payment of interest on the bonded debt (exclusive of water debt) and for creation of a sinking fund for amortization of the debt as it matures.

Second: Water revenue, the receipts of which are derived from users of water and can only be used for the maintenance and upkeep of the water department, the construction and extension thereof, and provide for payment of interest and sinking fund on the water debt.

Third: This group is denominated Municipal Revenue Fund, and is credited with all the city's revenues not legally belonging to the other groups. The receipts of this fund must be sufficient to maintain all the city's departments, institutions and activities, exclusive of the water department, and up to the close of our last fiscal year, April, 1920, while the revenue has not been ample or sufficient, necessitating curtailment of many desirable city improvements, yet we have managed to live within our means, closing the various years with a small balance on the right side of the ledger, until last April, the deficit of that year being $28,364.83.

During the years 1916 to 1919 inclusive there was set aside out of the current year's municipal revenue receipts $3,069,317.83 for new public work, including among other purposes: The city's share of cost of improving streets and constructing sewers; additions to hospital buildings; purchases of real estate; constructing public sewers; constructing municipal docks; installing and equipping lighting system, etc.

We believe that current revenue receipts should not be burdened with demands for permanent improvements, but the constitutional limitations regarding the borrowing of money, make it necessary to finance many such improvements from ordinary revenue, or dispense with them entirely.

During the period under discussion (1916 to 1919) the cost of improving and reconstructing streets was $3,422,924 and for constructing sewers was $2,310,294. The manner this $5,733,218 outlay for public work was financed is, I believe, peculiar to the city of St. Louis. To pay the contractors, the city delivers to them, on completion and acceptance of the work, special tax-bills, which are first lien, except the lien of general taxes, against each piece of property affected. The city government in projecting work of this nature must only provide means of supervision and the necessary clerical work in making out and recording the tax bills, advertising the lettings, etc. The question, therefore, of financing all our street and sewer improvements, except that of public sewers, is one the successful bidder must solve. He must also, and at his own expense, provide means and place where the tax-bills must be paid, or dispose of them as is usually done to some financial institution. Ordinarily it is not difficult to dispose of them at or near their face value, as they are considered a safe and reliable investment, bearing interest at 8% if not paid promptly.

While it may not be entirely pertinent to the subject under discussion, I wish to state in closing, that the gross outstanding debt of the city of St. Louis April, 1920, was $16,440,000 exclusive of $2,624,000 water debt. That the cash and investments held in our Sinking Funds was $6,473,869, leaving a net debt at that date of $11,474,897.00; The smallest debt, I am sure of any city in the country of half its size or importance. Whether that is a matter to be proud of or not, it is however a fact.

REPORT OF COMMITTEE ON STANDARD TESTS FOR BITUMINOUS MATERIALS

Your Committee on Standard Tests for Bituminous Materials herewith respectfully submits its 1920 Report.

In its 1918 Report, the committee recommended that the Society adopt methods of testing bituminous materials which have given useful, satisfactory and reliable results. It called attention to the fact that it is highly desirable that methods of conducting a given test in different laboratories should be as uniform as possible and that, as far as practicable, methods of testing adopted by national organizations should be identical.

Your committee, therefore, recommended that the Society tentatively adopt, until the 1919 Convention, specified methods of testing as described in the publications of the American Society for Testing Materials and the American Society of Civil Engineers under the conditions noted in each case. In its 1919 Report, your committee recommended that the methods of testing embodied in its 1918 report and amended in accordance with the 1919 revisions adopted by Committee D–4, Am. Soc. Test. Mat. be tentatively adopted by the Society until the 1920 convention.

In its 1918 and 1919 reports, the committee requested the submission of criticisms and suggestions relative to the methods of testing, especially from the Specification Committees and members of the Society interested in tests for bituminous materials. No communications relative thereto have been received by the committee.

Your committee, therefore, recommends that the Society now adopt, as standards, the following methods of testing under the conditions noted in each case:

Specific gravity of road oils, road tars, asphalt, cements and soft tar pitches, as described in the 1920 report, Com. D–4, Am. Soc. Test. Mat., pages 9-12.

Specific gravity of asphalts and tar pitches sufficiently solid to be handled in fragments, as described in the 1920 report, Com. D–4, Am. Soc. Test. Mat., pages 13-15.

Flash point test, as described in the Am. Soc. C. E. Trans., Vol. 82, 1918, pages 1449, 1450.

Penetration test, as described in the Am. Soc. Test. Mat., 1918 Standards, pages 632-634.

Viscosity test with Engler viscosimeter, as described in the Am. Soc. C. E. Trans., Vol. 82, 1918, pages 1452, 1453.

Float test, as described in the Am. Soc. C. E. Trans., Vol. 82, 1918, pages 1453, 1454.

Ductility test, as described in the Am. Soc. C. E. Trans., Vol. 82, 1918, pages 1460, 1461 (eliminate testing at 4° C. (39° F.)).

Softening point of asphaltic products as described in the Am. Soc. Test. Mat., Proc. Vol. 18, Part I, 1918, pages 707, 708.

Softening point of tar products, as described in the Am. Soc. Test. Mat., Proc. Vol. 19, Part I, 1919, pages 764-767.

Distillation test, as described in the Am. Soc. Test. Mat., 1918 Standards, pages 669-672.

Fixed carbon, as described in the Am. Chemical Soc. Journal, Vol. 21, 1899, page 1116.

Solubility of bitumen in carbon tetrachloride, as described in the Am. Soc. C. E. Trans., Vol. 82, 1918, page 1452.

Loss on heating of oil and asphaltic compounds, as described in the Am. Soc. Test. Mat., Proc. Vol. 19, Part I, 1919, pages 732-735.

Your committee has deferred making recommendations pertaining to the tests for solubility in carbon disulphide and solubility of bitumen in naphtha as it is desired to give further consideration to certain details of these tests and in order that the tests recommended may be unanimously supported by the members of the committee.

Your committee believes that the primary function of the Special Committee on Standard Tests for Bituminous Materials, is to serve the Society as a committee to review new methods and modifications of present methods of testing bituminous materials and to recommend to the Society, from time to time, such changes in its standards as may seem desirable.

Respectfully submitted,
ARTHUR H. BLANCHARD, *Chairman*
PREVOST HUBBARD,
LESTER KIRSCHBRAUN,
FELIX KLEEBERG,
FRANCIS P. SMITH.

REPORT OF COMMITTEE ON STREET PAVING

W. A. Howell, Chairman, Newark, N. J.

The present year has been a very difficult one in the work of handling and solving problems connected with paving. As has been well stated by a Past President of this society, speaking for his own city, "Our work has been greatly delayed due to labor troubles on railroads and to the scarcity of freight cars for shipments. A number of our improvements, involving street paving, have been abandoned for this year, due to the inability to secure delivery of materials needed for their construction. The city has also been confronted with the prevailing high rate of interest demanded for temporary loans, and for this reason the sale of bonds for authorized improvements has been deferred. The unit prices for various types of pavements are exceedingly high, and, as a result of this condition, only the more important and urgent improvements are being made."

Another great drawback to street paving is the deplorable condition of street railway-track paving, due to the semi-bankrupt condition of most of the street railway companies in the large cities. In cities where the public service corporations are required to do their own paving, independent of the roadway paving done by the municipality, owing to the poor financial condition of these companies, their roadbeds are not kept in good physical condition, and the railway-track pavement not only suffers thereby, but it also affects adversely any perfectly good pavement laid adjoining the tracks by the municipality itself. In the city of the writer, the situation referred to has become a burning issue, and it must be solved, even if additional legislation is necessary, so that the municipality may control the situation without absolute confiscation of railroad property. The city should, if possible, absolutely control the paving of the entire width of roadway, including the street railway tracks, all being done at the same time, by the same contractor, and under the same specifications. Of course, by placing header curbs outside of the ends of the cross ties, on streets carrying street railroads, the municipal roadway paving can be practically separated from the street railway paving. The disadvantage of this plan (which is in use in a number of important southern cities) is, that it makes it possible for the Street Railway Company to defer improvements until the last possible moment consistent with safety. The appearance of the street as a whole suffers very materially from this method of treatment.

The suggestion made by Mr. Sammelman of St. Louis, in his report published in the Proceedings of 1919, that the installation of service connections, such as sewer and water, and public utility connections, such as gas, electric light and telephone pipes, should precede the paving of the street by at least one year—is a good one. In some cities this plan is impossible to carry out, because the public utility companies will not lay their conduits until the paving contracts have been awarded, and the contractors would not, under present conditions, accept contracts one year in advance of when they will be allowed to commence actual construction. If it is possible to originate paving programs two or three years in advance of paving, the municipal service connections could be taken care of, at least, and even that would help the situation very materially.

We are passing thru a period of abnormal conditions. The railway situation is out of joint, but there is a prospect of a gradual return to normal conditions. The price of materials requires considerable adjustment; the labor situation needs drastic treatment. One situation hinges on another. If there is a break in the labor situation there may be a rational adjustment of the railroad problem, and of the material problem.

Where traffic on the public highways has doubled, trebled and quadrupled, owing to the greatly increased use of motor trucks for the transportation of goods formerly carried by the steam roads, the maintenance of these roads is a very difficult proposition on account of the reasons set forth above.

Your chairman has been in connection with municipal engineers located in all parts of the United States and Canada, and has requested information as to paving programs for 1920. In the majority of instances this information has been cheerfully supplied, altho it may have been the cause of considerable annoyance and trouble to the Engineer supplying the information desired.

Providence, R. I., M. H. Bronson, City Engineer, Walter F. Slade Commissioner of Public Works

All sheet-asphalt pavements have been laid on old water-bound macadam or rolled broken stone base, very satisfactory but not laid for use under the heaviest of traffic. Granite block has been laid upon rolled stone base treated with about 2 gallons of Texaco asphaltic road binder per square yard, and covered with sand, expected to be very satisfactory for our heaviest traffic, because the blocks are grouted with portland cement. Much old water-bound macadam has been scarified 2 inches, sufficient 1½-inch trap rock rolled in to bring the surface to grade, then penetrated with about 1¾ gallons of asphaltic road binder and finished with ¾ inch of stone and about ½ gallon of asphaltic road binder for a seal coat, with splendid results and cost less than $1.00 per square yard; a better treatment than the use of a blanket coat, even at the difference in cost.

About 18,000 sq. yd. of granite block pavement, and about 5,000 sq. yd. of bituminous macadam by penetration method will be completed by municipal help and about 15,000 sq. yd. of new asphalt pavement and 8,000 sq. yd. relaid under contract. The cost ranges as follows:

Sheet Asphalt: 1½-inch binder, 1½-inch surface, $1.80, $2.40, $2.35 per sq. yd.; 1-inch binder, 1½-surface $2.90.

Asphalt Patching, including binder or cushion coat, $3.75; for 6-inch asphaltic penetration on cement concrete foundation less than two sq. yd. $4.40, greater than two sq. yd. $3.45 a sq. yd.

Granite Blocks: On 6-inch cement concrete or asphaltic penetration base $5.98 sq. yd.

Penetration: 6-inch thickness (Including $25.00 per day for roller) $2.02 sq. yd.

Blanket Coat: $16.89 per sq. yd.

Portland, Me., Edward M. Hunt, Commissioner of Public Works

Program for 1920: Split, redressed granite block pavement on concrete base, 3,680 sq. yd. to cost $15,824; vitrified brick pavement on concrete base, 2,150 sq. yd. to cost $14,298; compressed concrete pavement, 2,111 sq. yd. to cost $6,650; concrete pavement with asphalt surface, 4,637 sq. yd. to cost $17,390; total 12,578 sq. yd. to cost $54,162.

Hartford, Conn., Roscoe N. Clark, City Engineer

Program for 1920; Asphalt, 16,270 sq. yd. to cost $76,203; granite block, 990 sq. yd. to cost $7,507.

New Haven, Conn., E. S. Nettleton, City Engineer

Contracts awarded: Bituminous macadam, 29,300 sq. yd., to cost $91,000; sheet asphalt-concrete base, 30,000 sq. yd. to cost $95,000; sheet asphalt on old macadam, 36,000 sq. yd. to cost $70,000; Topeka on old macadam, 7,000 sq. yd. to cost $16,000; 1:2:4 batch concrete, 26,000 sq. yd. to cost $81,000; total, 118,300 sq. yd. to cost $353,000.

Much delay from insufficient cement. Asphalt is secured more readily and such work is progressing more favorably.

Boston, Mass., Joshua Atwood, Engineer in Charge, Bureau of Paving Service

Considerable delay from late wet spring weather, shortage of labor, non-receipt of material, completion of underground construction. No work dropped on account of high prices, but number of bidders has been noticeably smaller.

Construction, reconstruction, resurfacing and repair will amount to about 1,250,000 sq. yd. Artificial stone sidewalk to 110,000 sq. yd. Contracts awarded and advertised amount to $654,408, covering smooth pavement, 76,145 sq. yd., and granite block 1,603 sq. yd.

Reconstruction and repair of streets by contract covers smooth pavement 28,910 sq. yd. and granite block 34,805 sq. yd., the contracts awarded and advertised amounting to $374,999.19.

Artificial stone sidewalks. Contracts awarded and advertised for 78,210 sq. ft.; sum of $54,036.39.

The total of all contracts is $1,083,444.44.

Albany, N. Y., Frank R. Lanagan, Chief Engineer

Has done mainly work left over from 1919 contracts not finished.

Syracuse, N. Y., Henry C. Allen, City Engineer

Streets were paved as follows: *Asphalt*, 5 streets, 38,546 sq. yd., costing $290,121; *Brick*, 3 streets, 5,159 sq. yd., costing $8,772; *Granite*, 1 street, 670 sq. yd.

Jersey City, N. J., Charles A. Van Keuren, Chief Engineer

Paving program for 1920 is as follows:

Class of Pavement	Sq. yd.	Cost
Asphalt, 6-in. concrete base, 2-in. surface, 1½-in. binder	50,349	$222,669.02
Asphalt over existing stone block, same thickness	62,871	180,965.80
Granite block 6-in. concrete base	20,900	150,480.00
Granite block over old concrete base	11,260	63,220.00
Old Belgian block, on new 6-in. concrete base	9,290	36,477.76
Bituminous concrete, 5-in. concrete base, 1½-in. surface, 1-in. binder	1,823	3,706.00
Total	156,493	$657,518.58

Atlantic City, N. J., J. W. Hackney, City Engineer

This city on May 20, 1920, contracted for approximately 52,300 sq. yd. sheet asphalt and 8,500 sq. yd. brick (principally gutters) and about 20,000 linear feet granite curbing at estimated cost of $356,657; time limit, 200 working days. Delays have been chiefly by shortage of cars, now greatly improved.

Newark, N. J., William A. Howell, Engineer in Charge, Bureau of Paving

This city has awarded very little work for the paving or repaving of important highways during the last three or four years. On account of the tremendously heavy truck traffic between Newark and New York, and also on account of the heavy thru traffic between New York and Philadelphia, all of which traffic passes thru Newark, the repair work essential to simply make the main arteries passable and safe for traffic would run up to a good round sum. Our 1000-yd.-capacity asphalt plant not being large enough to do the work required, the city is installing a new Warren plant, costing some $35,000, having a daily capacity of 1800 yd. of 2-inch top surface. This plant will be ready for use by November 1st of the present year, and will be a valuable asset to our city. Sealed proposals were received this year for a number of important improvements, but on account of the high cost of labor and materials, several of these proposed improvements were laid over until another year. The city has awarded contracts amounting to approximately $125,000 for new steel bridges over the Morris Canal at Heller Parkway, Plane Street, Washington Street and Halsey Street. Sealed proposals will soon be received for rebuilding the bridge over the Morris Canal at River Street, Newark. The new bridges at Heller Parkway, Plane Street and Halsey Street have been completed, and are able to carry the heaviest of loads. One of the most important highway improvements contemplated within recent years is the proposed paving of Passaic Avenue, paralleling the Lincoln Highway, from Richard St. (the present west terminus of the wood block pavement) to the junction of Passaic Avenue with Market Street. Alternate bids will be received for this work with reinforced concrete and granite block on an 8-inch concrete base. A considerable mileage of worn out Telford and brick pavement will soon require resurfacing with some bituminous pavement. This work will probably be deferred until 1921.

Work Awarded During 1920

			Estimated Cost	Average Price per sq. yd.
Concrete pavement	35,860	sq. yd.	$208,025.60	$ 3.78
Napped, reclipped granite on built-up base	14,800	"	126,149.00	3.50*
Reclipped trap block	6,275	"	40,581.00	4.94†
New granite on new concrete	420	"	5,157.00	10.00†
Asphalt block	2,450	"	22,291.50	6.90†
Totals	59,805	"	$402,264.10	

*Not including cost of concrete.
†Including new concrete base.

Bids will shortly be received for the paving of Lister Avenue with concrete, Passaic Avenue with alternate bids for both concrete and granite block on an 8-inch concrete base, and on Ridgewood Ave. for asphalt.

Sealed Proposals, October, 1920

			Estimated Cost
Sheet asphalt (2-in. top, 1½-in. binder, 6-in. concr. base)	5,250	sq. yd.	$ 33,500.00
Concrete pavement (Aver. thickness 9 in.)	22,500	"	156,000.00
Total	27,750	sq. yd.	$189,000.00

In case granite is selected as the paving material on Passaic Avenue instead of concrete, the cost will be $63,550 additional, or $252,550, the yardage remaining the same.

New York City (Boro of Brooklyn), Herman H. Smith, Chief Engineer of Highways

Work delayed, principally by difficulty in obtaining paving materials. Appropriation for repaving is about $2,500,000 and to July 27 only about $700,000 were under contract and $650,000 about to let. Balance will be let during the year. Practically all important street railway companies are in the hands of a receiver and little street work has been done by them, a very serious handicap. The above appropriation for repaving made by the city. A vast number of petitions for paving, grading, etc., from property owners, requesting improvements paid by the assessments on property have been received which will amount to almost $1,000,000.

New York City (Boro of the Bronx), Josiah H. Fitch, Engineer in Charge

The Paving Program for 1920 was the following:

Granite Blocks, Modern, on a concrete foundation	126,515	sq. yd.
Granite Blocks, Redressed, on a concrete foundation	6,180	"
Granite Blocks on Sand	75,950	"
Granite Blocks, Durax, on a concrete foundation	10,280	"
Sheet Asphalt	98,030	"
Bituminous Concrete (Topeka)	6,985	"
Asphalt Blocks	13,500	"
Total	337,440	sq. yd.

The estimated cost of the above work is $2,492,580.74, of which $1,775,524.35 is for the pavement proper and its foundation. Of the above work to date, $1,096,411.61 worth of work has been completed, which includes $751,025.35 for the pavement and foundation. One cause of delay in granite block paving has been the fact that, in this district, at least, the Granite Block Pavers' Association had set as a maximum amount of pavement to be laid by any paver during a working day, at 40 square yards, and the pavers are not allowed to exceed this. The rate of pay for this amount of work has been fixed at $10 per day by the Pavers' Union. There has been very little, if any, delay this year, in the laying of asphalt pavements.

Rochester, N. Y., C. Arthur Poole, City Engineer

Not much paving work this year due to high costs, and for two months due to strikes, the most serious one being of the unskilled labor.

The following paving work is in progress, to be completed this year:

67,600 sq. yd. sheet asphalt pavement averaging $3.90 per sq. yd. (without excavation).

17,000 sq. yd. asphalt resurfacing, at an average price of $2.25 per sq. yd.

3,500 sq. yd. of brick pavement, at an average price of $5.10 per sq. yd. (without excavation).

Buffalo, N. Y., Geo. F. Fisk, Assistant Engineer

Our paving program on January 1, 1920, amounted to 508,402 sq. yd. at an estimated cost of $2,537,215. Of this amount, contracts have been signed for 244,410 sq. yd. costing $1,124,682. We have completed to date (July 23, 1920) 37,528 sq. yd., costing $190,988, and have now underway 74,310 sq. yd., costing $383,575. We have not dropped any work on account of the estimated cost of the same being regarded as prohibitive. At least 50% of our work has been held up by railroad congestion.

Baltimore, Md., R. Keith Compton, Chairman Paving Commission

Work has been greatly delayed by labor, material and transportation difficulties, and at least 25% of the work will be carried over until next year. The rise in prices since 1916 in some cases is over 100%. As our standard paving is sheet asphalt, this will give a very accurate guide.

	Under Contract		
	Paving Commission	Annex Commission	State Road
Sheet asphalt paving on reconstructed base.........	....	....	64,450 sq. yd.
Sheet asphalt pavement (1½-in. wearing surface, 1½-in. binder, 6-in. concrete base)	44,750 yd.	98,500 yd.	20,500 "
Old granite block (not red) 6-in. concrete base, cement filler..................	5,832 "	....	....
Old granite block (not red) 4-in. concrete base, cement filler, including liners.....	650 "	....	....
Block vitrified (3-in.), 6-in. base, cement filler............	655 "	....	300 "
Vitrified block (4-in.), hill pavers, 4-in. concrete base, cement filler	2,210 "	....	....
Vitrified block repaving, 6-in. concrete base, cement filler	245 "	....	....
Old granite block, reduced and relaid, 6-in. concrete base, cement filler............	6,560 "	4,800 "	300 "
Vitrified block gutters (3-in.) 6-in. concrete base, cement filler..................	2,905 yd.	8,300 "	....
Cement concrete 6 in. thick...	....	28,700 "	....
Cement concrete 7¼ in. thick.	4,750 "	....	....

Summary—		
Paving Commission	68,557 sq. yd.—Estimated Cost	$ 310,000
Annex Commission	140,300 " — " "	470,000
State Road	85,550 " — " "	297,645
Totals	294,407 " —	$1,077,645
Completed—		
Paving Commission	25,862 sq. yd.—Estimated Cost	$125,000
Annex Commission	77,000 " — " "	300,000
Totals	102,862 sq. yd.	$425,000

Charleston, S. C., J. H. Dingle, City Engineer

Of 130,000 sq. yd. of sheet asphalt pavement this year proposed little will be laid on account of drain construction and renewal delaying it until next year. The lowest bid received for sheet-asphalt pavement, 1½-inch top, 1½-inch binder and 4-inch concrete, was $3.71 per sq. yd. For the same on 5-inch base the bid was $4.12. Labor and transportation trouble has not affected our work, except as to prices bid by contractors, and as to time demanded for completion of work.

San Antonio, Texas, Hans Helland, City Engineer

The paving program for the year was 25 miles of streets, 7.9 miles having been completed, and 17.1 miles remaining to be reconstructed. The work has not been delayed on account of strikes or transportation trouble, but more on account of high prices of cement and scarcity of labor. The cement trouble is now settled and the scarcity of labor will not be relieved until the cotton picking season is over. It must be understood that the majority of laborers are Mexicans, who during the cotton season seek the field, better wages being paid there than in the city, and, as stated before, when the cotton picking season is over, the latter part of November, I think we will have sufficient labor to carry out our program. Our fiscal year runs from June 1, 1920 to June 1, 1921.

Houston, Texas, J. C. McVea, City Engineer

We laid approximately 75,000 sq. yds. this year. We are being delayed from time to time by one or more of the following troubles: Shortage of concrete material, of cement, of railroad cars and of labor. At the present time, cement has become more plentiful, due to an increase in the capacity of the local plant, but railroad cars are scarcer, which interferes with prompt delivery of concrete aggregate. Labor is also very short at the present time, due to this being the cotton season, which usually drains the southern cities of a large percentage of its labor. We have been further handicapped this year by almost continuous rains. The month of August, usually our driest month, has registered 15 inches of rain, there being about 25 rainy days in the month. The entire year has been unusually wet, which has caused perhaps more delay than anything.

Pittsburg, Pa., N. S. Sprague, Chief Engineer

Work greatly delayed by railroad troubles causing a number of street paving projects to be abandoned for this year. Also the high rate of interest demanded for loans has deferred sale of bonds.

Paving Program 1920

		Contracts Completed	Contracts in Progress	Total	Per Cent Completed
Block stone	sq. yd.	44,097.82	52,642.65	97,740.47	45.117%
Vitrified brick	"	15,408.23	22,150.00	37,558.23	41.022%
Asphalt	"	18,260.40	88,645.00	106,905.40	17.081%
Asphalt block	"	....	280.00	280.00	....
Asphaltic cement	"	....	5,435.00	5,435.00	....
Asphalt resurfacing	"	....	43,044.00	43,044.00	....
Wood block	"	....	50.00	50.00	....
Total	"	77,766.	213,247.	291,013.	26.723%

Estimated cost of paving program—$1,310,000.
(Asphalt resurfacing done by city force excluded from above figures.)

Peoria, Ill., L. D. Jeffries, City Engineer

Our paving program for the year 1920 included approximately 75,000 sq. yd. brick, 50,000 sq. yd. sheet asphalt on old brick as base, 30,000 sq. yd. sheet asphalt on concrete base.

Contracts have been let, or work completed, upon the following yardage: 45,000 sq. yd. brick, 30,000 sq. yd. sheet asphalt on old brick as base, 10,000 sq. yd. sheet asphalt on concrete base.

The cost of a 3-inch brick surface upon a 4-inch concrete base with asphalt filler, runs about $4.00 per sq. yd.; sheet asphalt on old brick about $2.00 per sq. yd.; and new asphalt work about $3.00 per sq. yd.

Most of the paving materials are to be found locally, with the exception of cement and asphalt. Transportation troubles have caused serious delays, together with a shortage of labor, and numerous projects have been abandoned after going through the proceedings and getting as far as the County Court because of advancing prices all along the line.

Minneapolis, Minn., Frederick W. Cappelen, City Engineer, Ellis R. Dutton, Asst. City Engineer

	Sq. Yards	Estimated Cost
Original Program for 1920	283,719	$1,222,215.35
Will be done in 1920	181,289	498,064.50
Work that cannot be done in 1920	102,430	724,150.85
Of this amount of 102,430 sq. yd., will be transferred to 1921 work, as money has already been provided for this work, under the Elwell Law.	61,342	283,250.00
The balance of which was ordered under the so-called Old Law, or the 5-year assessment proposition, must be re-ordered.	41,088	440,900.85

The delay was caused largely by lack of material, both of blocks, bricks and cement; in particular, cement and shortage of labor.

30.9 miles of sidewalks were ordered for this year, but we will only be able to build 22.8 miles, leaving a balance of 8.1 miles.

25 miles of curbing was ordered for this season, of which, we have only been able to build 6.3 miles, leaving 18.7 miles uncompleted.

As we were absolutely unable to get the necessary cement the work can only be completed as above shown.

St. Paul, Minn., Oscar Claussen, Chief Engineer

We expect to lay about 250,000 sq. yd. of pavement, costing, us in the neighborhood of $1,000,000. While there has been a general shortage of labor and material, we have not been seriously crippled, but the prices have run very much higher than in 1919. Our last price for cement was $4.00 a barrel, net (August 26th), which is 80% to 90% more than we paid in 1919, and it is hard to get.

Salt Lake City, Utah, Sylvester Q. Cannon, City Engineer

The plan was delayed slightly by shortage of materials, owing to lumber-men, railroad and cement-worker strikers, but conditions were practically normal again. During the year there have been constructed, or are under construction, improvements as follows:

			Estimated Cost Complete
Water mains	3.32	Miles	$ 21,215.00
Paving extensions	7.86	"	915,556.00
Sidewalks	7.62	"	38,910.00
Curb and gutter	6.74	"	105,438.00
Sanitary sewers	1.66	"	43,853.00
Storm sewers	4.67	"	84,854.00

The width of roadway paved in Salt Lake City is far above the average, the 7.86 miles representing 167,114 sq. yd. of actual pavement.

Birmingham, Ala., Julian Kendrick, City Engineer

We will practically complete 125,000 sq. yd. of street paving this year, at an approximate cost of $357,000, exclusive of the cost of curb-stone and sidewalk paving. We would probably complete more than double this amount of work, but for scarcity of labor and material and delays in transportation.

Columbus, O., Henry Maetzel, City Engineer

The street paving program for the year 1920 proposed to do the following amount of work: Asphalt 64,443 sq. yd.; brick 35,611 sq. yd.; concrete 941 sq. yd.; total, 100,995 sq. yd.; estimated cost, $475,656; total length, 28,325 or 5.36 miles.

All of our work, held over from last year or awarded this season, has been delayed by the following causes: Cement shortage said to be due to inability to obtain cars; shortage of stone curbing, due to inability to obtain cars; slight delays on sand and coarse aggregate, due to local conditions, wet weather and flood protection work; labor shortage.

Montreal, Canada, J. E. Blanchard, Engineer in Charge

Paving Program for 1920

Pavement

Asphalt, 274, 584 sq. yd. Average cost of $3.56 sq. yd.

Granite block, 37,735 sq. yd. Average cost of $6.55 sq. yd.

Sidewalk

Concrete, 51,651 sq. yd. $6.00 per sq. yd.

Cement curb. Average cost of $1.60 lin. ft.

Stone curb. Average cost of $1.50 lin. ft.

Calgary, Can., George W. Craig, City Engineer

Paving program for 1920 was not a large one. Our total yardage will not exceed 15,000, completed without any serious disadvantages, but at costs exceedingly high. Labor conditions fairly satisfactory, shipment of materials very slow. Asphaltic concrete 2-in. on 6-in. portland cement concrete base will cost about $3.30 per sq. yd.

Spokane, Wash., A. D. Butler, City Engineer

We have laid only 6,567 sq. yd. of paving but will, before the season closes, lay 4,000 more yards of bituminous pavement, both jobs of 3-in. bituminous concrete base and 2-in. bituminous concrete top.

San Francisco, Cal., M. M. O'Shaughnessy, City Engineer

While we have not done anything within the past year in connection with paving construction that might be considered either startling or revolutionary, we have made a radical change in the reduction of the thickness of our street pavements, which I believe will reduce rolling and other kindred troubles to a minimum. Our new specifications call for a 6-inch concrete base, an asphaltic-paint binder applied by means of a power sprayer, and a 1½-inch asphaltic concrete top. Our past experience leads us to believe that this will give very satisfactory results and will be of sufficient thickness for ordinary traffic streets.

Private Street Work Done

Kind	Area	Cost
Asphalt, 6-in. concrete base	3,126.67 sq. yd.	$ 7,781.91
Asphaltic concrete, 6-in. concrete base	18,363.61 "	47,371.05
Concrete pavement, 6-in. base	11,159.78 "	32,846.16
Asphalt with vitrified brick strip	1,337.46 "	3,796.31
Asphaltic concrete	1,420.47 "	4,643.41
Manholes, curbs, catch-basins, etc.	....	79,501.16
		$175,940.00

Public Street Work Done

Kind	Area	Cost
Asphalt, 6-in. concrete base	49,075 sq. yd.	$103,455.06
Asphaltic concrete, 6-in. concrete base	36,588 "	81,753.13
Vitrified brick, vertical fiber	2,481 "	10,023.64
Vitrified brick, hillside fiber	1,166 "	4,653.75
Asphalt with vitrified brick strip	14,402 "	38,996.34
Asphaltic concrete vitrified brick strip	5,886 "	18,963.07
Curbs, sidewalks, sewers, etc.	....	132,970.48
		$390,815.47

Amount and cost of city street work, city pay, $153,869.92

Oakland, Cal., George Mattis, Sup't of Streets

Completed Improvements

1.434	miles standard pavement	$122,047.45
6.64	" oil macadam pavement	307,169.11
1.418	" sanitary sewers	10,443.38
1.072	" storm sewers	33,664.78
		$475,324.72

Los Angeles, Cal., E. A. Tuttle, Engineer of Streets

No preliminary paving program. Little ordered until petitioned for by majority of property owners on the proposed improvement. July 1, orders were on file covering improvement work as follows: paving, 13 mi.; grade, gravel and oil surface, 27 mi.; curb and sidewalk, 15 mi.

It seems reasonable to predict that during the present fiscal year the value of improvements that will be made will exceed the sum of $3,000,000.

Portland, Ore., O. Laurgaard, City Engineer

Pavement completed between Dec. 1, 1919 and Aug. 1, 1920; asphaltic concrete, 2.7378 mi., asphaltic concrete redress, 0.2951 mi., concrete, 1.7350 mi., stone block, 0.0113 mi., total hard surface, 4.7792 mi.

ASPHALT PRODUCTION, REFINING AND RELATED PROBLEMS

By Herbert Spencer, C.E., Standard Oil Co. of N. J., New York City

The uses of asphalt insofar as applied to paving work are included under the general headings Sheet Asphalt Pavement, Asphalt Concrete Pavement, Asphalt Macadam and other types of pavement both patented and not patented, differing in various degrees and depending upon the size and character of the aggregate used and the particular methods adopted for producing the pavements to be laid. Asphalt in some form enters into the construction of all the above types, and other features include the following:

(1) The Asphalt Cement

(2) The Mineral Aggregate

(3) The Mixing, Laying and Rolling.

Specifications in general use are definite in regard to the characteristics of all the ingredients entering into an asphalt pavement, defining either by physical or chemical tests the properties each must possess to make them suitable for use. In a similar way specifications define the machinery required for the mixing, temperatures necessary to secure results, also careful instructions are included in the specifications for the spreading and rolling.

Practically everyone is familiar with the process required to quarry and crush stone, and most of the other materials used in the construction of pavements in general. However, little has been written on the production and refining of asphalt cement used in paving work, and the object of this paper is to describe briefly some of the features entering into the production, transportation and refining of the oil from which asphalt is made, together with some of the problems incidental to the shipping of the finished product and the handling at the asphalt plant.

As the Mexican asphalt has been extensively used in all classes of paving work thruout the eastern part of the United States, the remarks will be confined largely to this grade, altho applicable to most asphalts used in paving work. As an indication of the extensive use of asphalt thruout the United States, the following table shows the comparison in square yards between

1. *An Oil Tanker Loading Off Shore*

asphalt pavements, stone-block, brick and cement-concrete pavements in sixteen cities thruout the country. Of types reported by 140 cities, asphalt comprises 61.2%, stone-block 14.1%, brick 13.8%, wood-block 4.0%, cement-concrete 3.3% and all other types higher than macadam or gravel 3.6%.

The quantity of asphalt produced from domestic oil, Mexican oil, and imported Trinidad and Bermudez asphalt and in use in the United States for various purposes, is shown by accompanying chart.

PAVING CENSUS

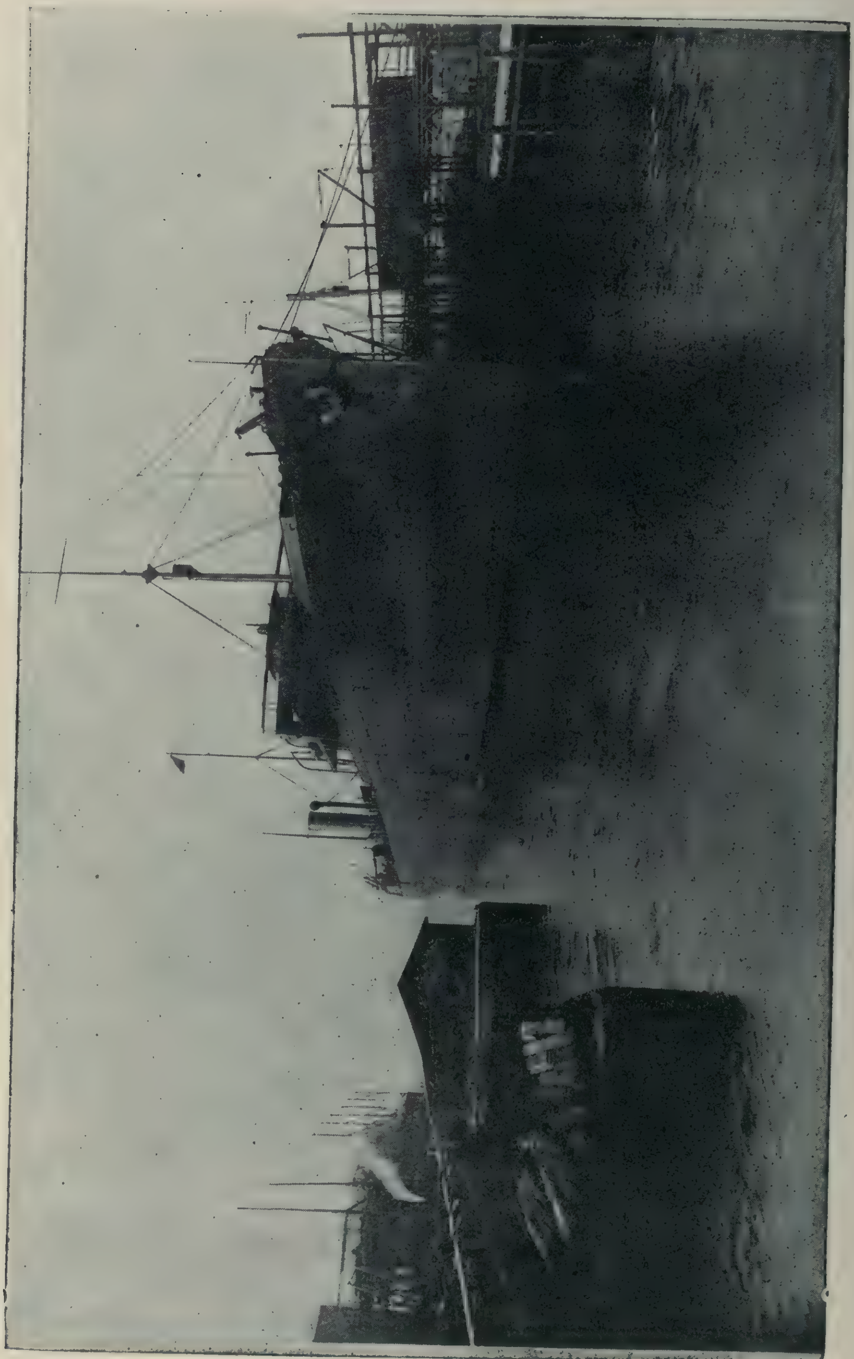
CITIES LEADING IN STREET PAVING

Higher Types in Square Yards

Cities	All types	PRINCIPAL TYPES			
		Asphalt	Stone Block	Brick	Cement Concrete
Percentages	100%	61.2%	14.1%	13.8%	3.3%
New York, N. Y.	35,531,159	24,922,620	8,834,244	316,022	42,372
Chicago	30,474,000	19,049,000	1,901,000	5,749,000	100,000
Philadelphia	19,833,508	10,098,868	6,414,140	2,811,160	98,378
Los Angeles	12,199,755	9,174,414	65,476	231,853	223,07
Kansas City	8,811,400	5,863,000	158,000	770,000	1,850,000
Portland, Oregon	8,638,500	6,610,000	216,000	42,000	1,722,000
Baltimore	8,287,628	3,996,247	998,878	1,236,732	46,927
Buffalo	7,207,544	4,830,737	1,681,363	693,828	....
Cincinnati	5,215,761	1,214,106	1,843,362	1,140,044	....
Omaha	4,685,655	1,942,455	502,317	2,074,272	135,321
Seattle	4,613,599	2,842,637	302,483	1,330,494	103,776
San Francisco	4,605,000	4,120,000	340,000	125,000	....
Washington, D. C.	4,570,178	3,918,189	404,225	17,390	168,239
Toledo	4,195,501	1,016,789	253,471	2,361,907	164,518
Rochester	3,271,066	2,124,290	....	1,091,174	....
Des Moines, Ia.	3,200,507	1,786,983	260	1,179,821	169,683

PRODUCTION AND TRANSPORTATION

Before the introduction of petroleum asphalt in the United States, dependence of supply was based largely upon the imported native asphalts from Trinidad and Bermudez. It is evident, however, that since the introduction of asphalts from domestic and Mexican petroleum, the demand for the native asphalts has steadily decreased. Continuation of supply from Mexican fields will largely influence the completion of the large road- and street-building program upon which we are now embarked, and altho conditions in Mexico are far from being settled, the field is still in operation and apparently has not been seriously affected by the large quantities of oil drawn from it



2. *An Oil Tanker Discharging Cargo at Refinery*

since it was first opened. In some sections of the Mexican oil district, and particularly in northern Vera Cruz, disturbing infiltration of salt water has affected a horizontal plane extending over a wide area, rendering unfit for use part of the oil produced. This has meant the extinction of many of the large producing wells, but prospecting in adjacent fields indicates a steady increase in the production of the Mexican oil.

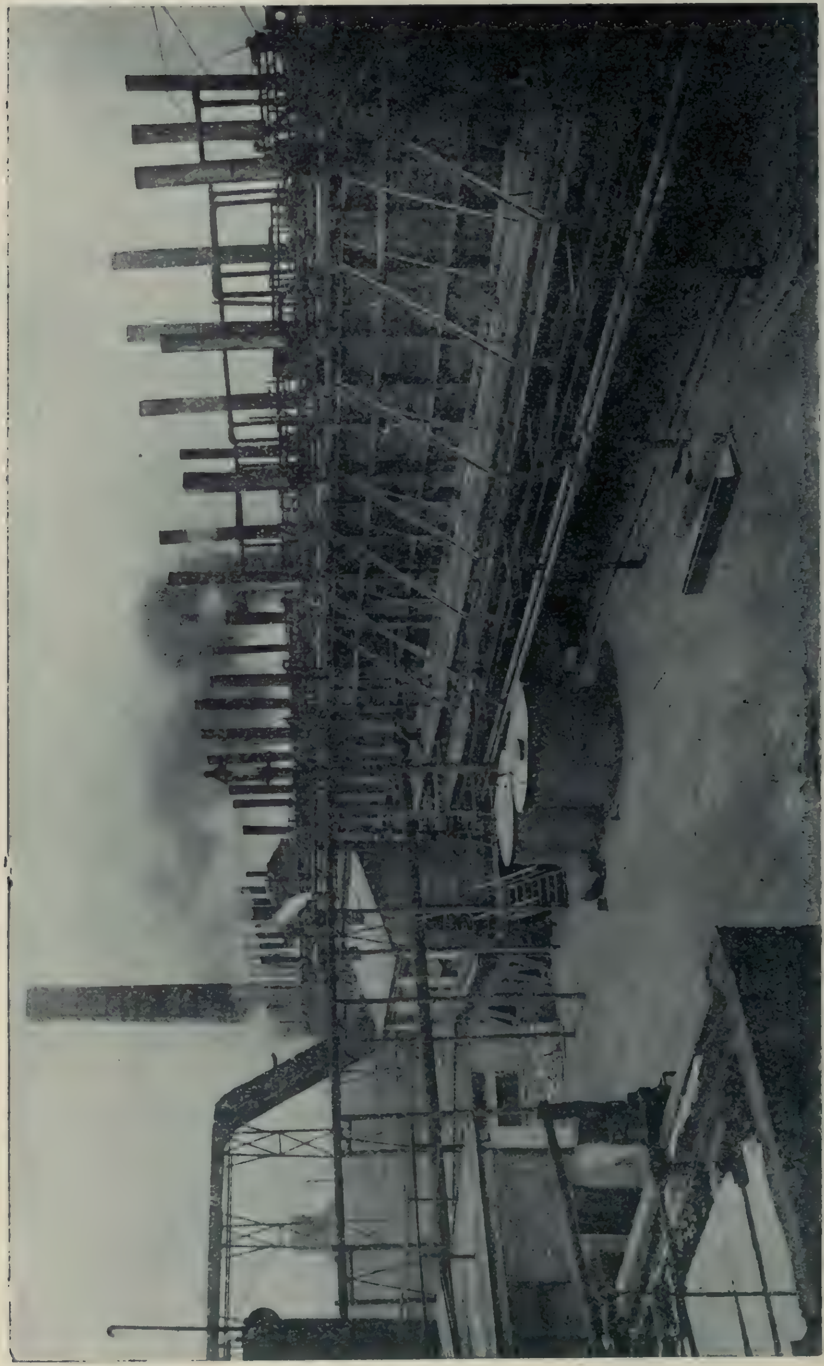
The main factors entering into the use of Mexican oil, based upon present conditions in Mexico are: (1) Price, (2) Pipe Line Facilities and (3) Transportation.

The Mexican Government by its new constitution has interpreted Article 27 to provide in a retroactive manner for naturalization of all oil lands. The export tax on the Mexican oil is so heavy that a considerable part of the value of the crude at the well is collected as taxes by the Mexican government. The construction of pipe lines from the fields to the Gulf of Mexico has facilitated the movement of the crude, and increased facilities in the way of pipe lines will materially add to the quantity which can be made available for transportation to the refineries in the United States. At the close of the war the number of tank steamers available for service in bringing Mexican oil to this country was limited. Tankers now in course of construction will be placed in this service as rapidly as possible and it is expected that this will aid in materially increasing the quantity of crude oil carried from Mexico to the United States and its reduction into asphalt for commercial use.

Tankers vary in size from 60,000 barrels to 115,000 barrels capacity and make the trip from Mexico to Atlantic ports in about eight days. They are all equipped with powerful pumps, and require about forty-eight hours to load and the same time to unload. Connections are generally 8-inch suction and 10-inch discharge. In some cases the oil from the well is loaded direct to the tanker, the pressure at the well being sufficient to force the oil thru the pipe lines and into the steamer. This has resulted at times in too rapid loading, as difficulty has been experienced in properly controling the flow.

REFINING

When the oil reaches the refinery, it is unloaded into storage tanks, and from there is charged to the stills. These stills are generally in batteries, the oil being reduced at a temperature of about 600° F. This operation takes about sixty hours, and necessitates maintaining the correct temperature until the material reaches the penetration desired. Over-heating or too rapid distillation would probably result in affecting some of the essential characteristics of an asphalt cement, such as ductility, susceptibility to climatic changes, and other features. Careful tests for penetration indicate when the material has reached the correct degree of hardness, and as the still-men become proficient



3. *A Battery of Asphalt Stills*

after handling large quantities of material, mistakes seldom occur. Retained samples of all material are kept for reference, and if any discrepancies in tests are reported, a comparison with the retained sample is made to determine what, if any, change has taken place since the asphalt left the refinery. Only accepted standards for testing are followed, those in common use being methods adopted by the American Society for Testing Materials, American Society of Civil Engineers, and similarly constituted bodies.

It might be well here to point out some of the difficulties that confront the refiner due to the great divergence in specifications, and particularly in reference to the variety of penetrations called for. Mr. Wallace L. Caldwell, of the Pittsburg Testing Laboratory, estimates the causes of failure of asphalt wearing surfaces as follows:

Unsuitable mineral aggregate	30%
Improper manipulation at mixing plant	25%
Poor workmanship on street	15%
Bad weather conditions	15%
Bitumen of improper consistency	10%
Bitumen unsuitable for paving	5%
	100%

The larger cities generally lay a heavy-traffic mix and a light-traffic mix, each of which requires an asphalt of different penetration. In addition to this, an asphalt for bituminous concrete is in great demand. These three grades constitute the bulk of material for the heavier forms of asphalt construction, and no hardship is imposed on the refiner to meet these requirements. The penetrations most commonly used are 35-45 penetration, 45-55 penetration and 55-65 penetration. However, when subdivisions of these grades are called for, it necessitates additional storage and materially affects the running of regular grades. At present refiners are asked to make asphalt of 35-40 penetration, 40-45 penetration, 45-50 penetration, 50-55 penetration, 55-60 penetration, 60-65 penetration and 65-70 penetration, and in some cases request is made to run a material to definite penetration. The discrepancies in the test for penetration as made by different operators leave much to be desired in the practical making of this test and unnecessary grades inflict a hardship on the refiner in keeping so many stocks, when probably not more than three grades would be sufficient to meet all the variations in hardness required in an asphalt cement. The committee on asphalt of the A.S.M.I. should study this matter, and this committee, in conjunction with the Technical Advisory Committee of the Asphalt Association, should determine the penetrations best suited for the different kinds of asphalt pavement, specifying these penetrations with allowable limits instead of leaving it

4. *Loading Rack for Tank Cars*

5. *Loading Platform for Package Shipments*

optional with the engineer to order any penetration he thinks best suited to his work.

After the asphalt has been reduced to the proper consistency it is pumped either to tank-cars or to storage-tanks. Tank-cars are loaded from an over-head rack, and barrels or drums filled from storage tanks. The tank-cars in use are from 6500 to 10,000 gallons capacity, and are equipped with steam-coils capable of heating the material so it can be pumped in from six to ten hours. Drums are first coated with a lining of clay or similar material to keep the asphalt from sticking, and are then filled from hand nozzles. Each drum is weighed before loading, stamped with the name of the material and such other identification marks as may be necessary, and then rolled into cars for shipment.

CONTAINERS

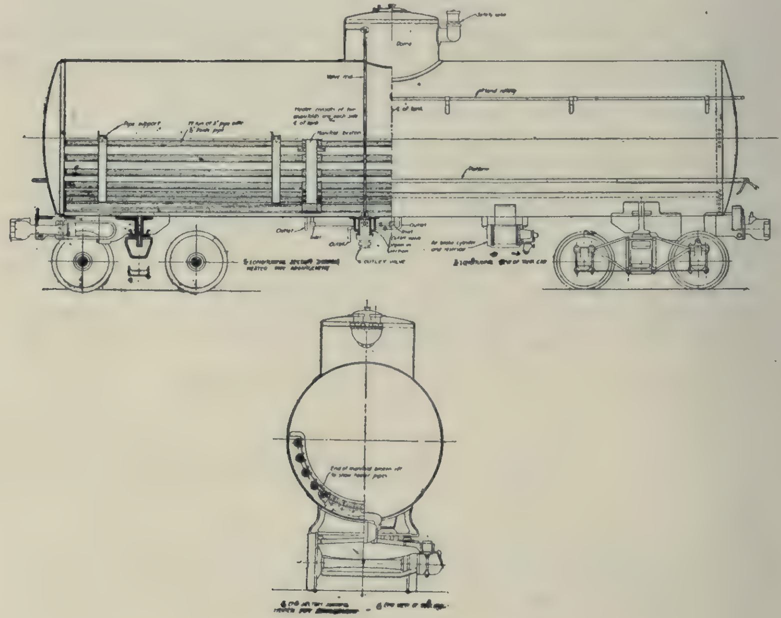
Intimately bearing upon the economy of asphalt work is the question of containers used for shipping and storing the asphalt. This material, flowing readily on the application of heat, makes it possible to handle in bulk, thus obviating the necessity of handling in packages. When shipments of Mexican asphalt from the Atlantic and Gulf ports became heavy in 1912 and 1913 it was necessary to arrange for the transportation of this material in bulk from the refinery to destination. Fortunately the tank-car had been handling asphalts for purposes other than paving for many years and required nothing new to enable it to handle the paving asphalt-cements. The tank-cars are equipped with steam-coils, and require a minimum of fifty pounds of steam to heat sufficiently to enable them to be unloaded in from ten to twelve hours.

Due to causes entirely beyond the refiner's control, he is at times confronted with conditions that make shipments uncertain, and when a combination of adverse conditions occurs, and especially during a season when demand is far in excess of supply, it is but natural that delays should be encountered. The Mexican asphalt supply depends upon the Mexican oil supply. Delivery to the refineries depends upon ocean transportation. Delivery to the consumer depends upon railroad conditions, and a mobile tank-car service. Shortage or delay in equipment, strikes or embargoes in transportation, affect the delivery of material to the consumer, and the present unsettled condition of all markets has caused delays unknown under normal conditions.

STORAGE

One feature that is of the utmost importance to the refiner as affecting prompt shipments of asphalt is the necessity of adequate storage at the point of delivery. With the increase in paving work, both in the cities and in the outlying districts, tank-car shipments have been called for to a much greater extent than package-shipments, due to the saving effected. On a basis of asphalt costing $33.00 per net ton delivered, and assuming a loss of 5% on material left in package, the following approximates the saving of tank-car shipments over package-shipments:

Extra cost of package	$ 8.00
5% loss in asphalt	1.65
Difference in labor of handling	.75
	$10.40



6. *Tank Car Showing Heater Pipes*

This is offset to some extent by the interest and depreciation charges on storage installation, but aside from the direct saving, the following indirect features indicate the greater efficiency of an asphalt plant equipped with adequate storage:

1. No demurrage on tank-cars.
2. Prompt return of tank-cars to refinery insuring continued shipments.
3. No shut-downs due to delayed shipment.
4. No overheated material or wasted heat.
5. No congestion on material tracks.
6. Hot asphalt continually available.
7. Can be made portable for use on different jobs.

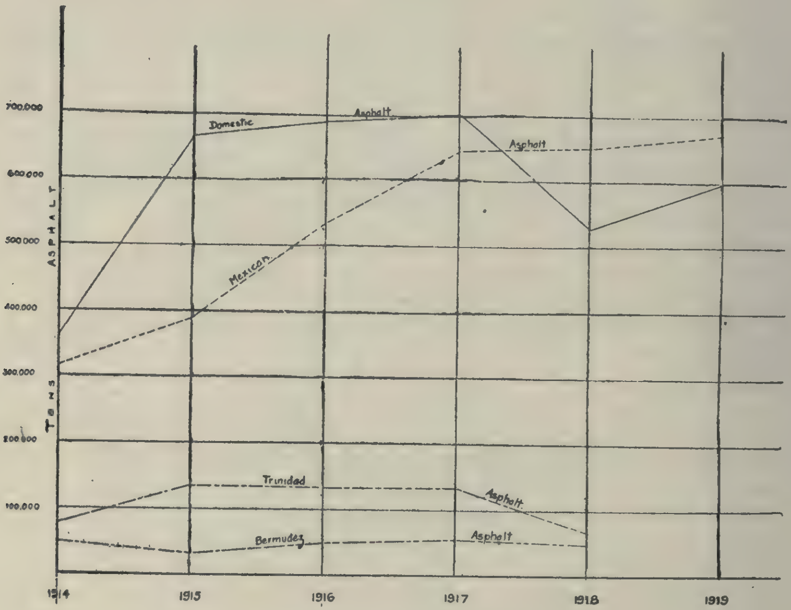
A survey of the contractors' end of the asphalt industry shows a decided shortage of storage facilities for asphalt, and has developed the fact that customers are utilizing tank cars for storage purposes. While this may be economical for the contractor, it creates a situation decidedly serious for the trade in general, as tank-cars are delayed in being returned to the refinery, with a consequent decrease in the number available for use. The following table for the two months (August and September, 1919) indicates the delays in releasing tank-cars, after receipt by the consignee. The figures are taken for shipments to contractors both with and without asphalt storage, and represent the number of cars held for different periods before release to the railroad. Shipments are from Bayonne, N. J., and Baltimore, Md., to points between Cleveland, Ohio, and St. Louis, Mo.

	Released within 48 hours	Between 48 hours and 5 days	Between 5 and 10 days	Between 10 and 20 days	Over 20 days
Aug. . .	35	16	10	4	5
Sept. . .	18	19	16	8	8

The average running time in 1919 between Atlantic Coast refineries and the vicinity of Cleveland was 19 days and from Atlantic refineries to vicinity of Chicago was 15 days. Assuming an average running time of 17 days from refinery to destination, the same time for return, a delay of 5 days at contractor's plant, beyond the free time allowed, requires 41 days between time tank-car is loaded and returned again for shipment. At the height of the paving season, and with transportation in the condition existing at present, it is obvious that the installation of adequate asphalt storage facilities will do much toward lessening the time taken in returning tank-cars, aside from the saving to the contractor. As a rule, municipal asphalt plants are equipped with adequate storage, and no delay is experienced in returning empty tank-cars. The same holds true for the larger contractors doing work in the cities. The greatest trouble is experienced from contractors having isolated jobs in the outlying districts and in smaller cities where the yardage is small, and the contractor feels that storage is not economical for him. The question is therefore raised as to what type of storage is most suitable for asphalt plants.

For the more permanent installations, tankage is either of steel or concrete. Steel tanks are either large vertical units, or a number of smaller units aggregating the total storage required.

In designing storage tanks for asphalt, the size of the work to be done is one factor to be considered. Other factors include the distance of plant from the refinery, the length of time shipments take to reach destination and the quantity of asphalt to be used per day. Sufficient asphalt should be kept on hand to last at least one week, and if possible, a reserve stock in barrels or drums. On account of the difficulty of securing sufficient capacity for a plant from one tank-car, it seems necessary to provide storage which can be set up at each location and can be salvaged for the next job. Such a type of storage tank is shown in the illustration. This consists of a large circular storage tank in the middle of which is set a heating-chamber equipped with steam-heating coils. The shell of the heating-chamber being bottomless the asphalt in the outlet tank is free to enter the heating-chamber. It does this when the tank is in actual service, new asphalt constantly flowing in from the outer tank to replace that used from the heating-chamber. Only the quantity needed for immediate use is kept hot and the mass in storage remains comparatively cool. This has the advantages of (1) economy of steam, there being no lost heat. All heat supplied is used in heating asphalt in the inner chamber, some penetrating to the outside mass and liquefying it sufficiently to enable it to flow into the heating chamber. (2) The asphalt is used as fast as heated, there being no chance for the penetration to change on account of prolonged heating.



PRODUCTION OF ASPHALT FROM VARIOUS SOURCES
1914 - 1919 inclusive

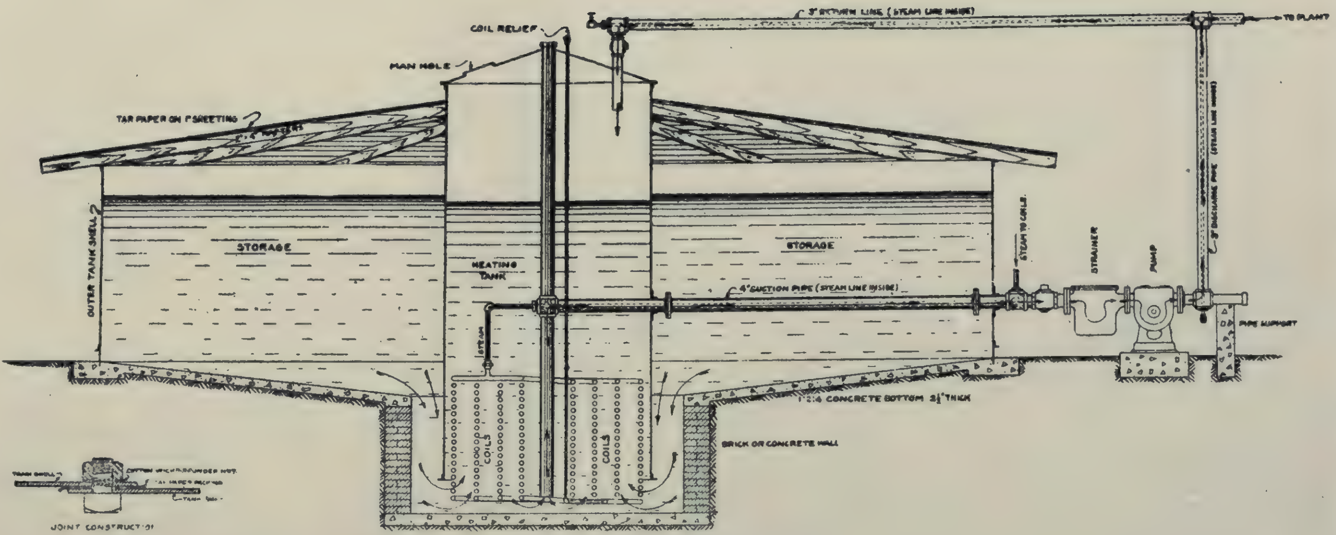
7. *Asphalt Production*

The pit for the tank is first prepared, the grade being set to allow for the sloping bottom. A 1 : 2 : 4 mixture of concrete is then placed $3\frac{1}{2}''$ thick, or thinner if the foundation warrants it. The coils, heating chamber and outer ring are then set, the plates for the outer ring being assembled in advance. This outfit is made in sizes from about 13,000 gallons to 90,000 gallons, costing with heating coils and pipe complete, also with asphalt pump and 25-h.p. boiler, from $1100.00 to $3000.00, exclusive of labor in setting up. This will run from 20c per gallon for the smaller sizes to 6c per gallon for the larger sizes. The tank is shipped knocked down in five sections and can be moved from one job to another by unbolting the shell sheets and packing together. The design is by Walter E. Mills of Chattanooga, Tenn., who furnished the descriptive matter for this design.

Other styles of tanks include the underground concrete tank, with floors 3 inches to 4 inches in thickness and walls about 5 inches in thickness. Great care must be exercised to have these tanks waterproof, as endless trouble will result if water is allowed to penetrate. This can generally be secured by the use of asphalt waterproofing paper, or by the use of some of the moist-proof compounds mixed with the concrete. In many cases it has been found economical to place the heating-chamber at one end of the tank, with openings in the bottom of the partition to allow the asphalt from the storage to flow into the heating-chamber. In this way the difference in temperature is maintained. The storage-tank is equipped with a limited number of heater-pipes, estimated as one square foot of heating surface to every 100 gallons of material. The heating-chamber should be provided with one square foot of heating surface to every 20 gallons of material.

In some localities, and particularly where refineries are situated close to the larger cities, it is possible to deliver heated asphalt to contractors' plants or to municipal plants by means of bulk barge. Some producing companies operate barges equipped with steam coils and having capacities approximating 55,000 gallons. The asphalt is loaded into the barge directly from the stills or from storage tanks; it is then conveyed to the asphalt plant, the heat being maintained in the barge while the asphalt is being transported.

The city of New York takes a large part of the asphalt supply for its municipal plants in this way. Barges make deliveries from the refineries located on the Jersey shore to plants both in Brooklyn and New York city. This, of course, is only feasible where plants have considerable storage and there are facilities for loading and unloading barges and depth of water sufficient to take a lighter and tug. The asphalt after delivery to the asphalt plant is pumped to storage tanks and from there is loaded to heating kettles and then to the mixing boxes; compressed air



8. *Section of Asphalt Storage Tank*

being generally used to transfer the asphalt from one point to another.

The operation of proportioning and mixing the ingredients for an asphalt pavement, regulating temperatures, transporting, laying and rolling the finished mixture, are matters beyond the scope of this paper. Different cities have specifications covering these particulars, and altho the principle is the same, specifications vary in many details.

DISCUSSION

J. S. Miller, Jr. (by letter)—It is unfortunate that the advance copy of this paper did not contain the statistical tables referred to in the text as it is impossible to prepare, in advance, an intelligent discussion of that phase of his paper, but certain general statements therein require some explanation.

Mr. Spencer makes the broad statement: "It is evident, however, that since the introduction of asphalts from domestic and Mexican petroleum, the demand for the native asphalts has steadily decreased." His preceding sentence clearly indicates that reference to native asphalts includes the two lake asphalts, Trinidad and Bermudez.

I take exception to the statement that the "demand" for the native asphalts has steadily decreased. As a matter of fact the demand has been greater than could be supplied since early in 1915. Shortage of ship tonnage and Governmental restrictions have been the factors limiting importations and never in the history of the Lake Asphalt industry has such a large tonnage been carried as unfilled orders.

Mr. Southgate: Is there any patent on the design for storage tank shown on the screen?

Mr. Spencer: The tank is made by Walter E. Mills, Chattanooga, Tenn. It is not my design.

Mr. Worcester: The tank shown has one advantage in that it is collapsible and can be shipped in a unit and only requires a concrete form to support it.

THE ELIMINATION OF UNNECESSARY TESTS FROM ASPHALT CEMENT SPECIFICATIONS

A Plea for Standardization

By R. R. Barrett, Engineer, Asphalt Sales Department, The Texas Company, New York City

The highway engineer's reputation largely depends upon his ability to design and construct good roads and pavements economically. The problem is to obtain the most durable type of pavement suitable to the traffic condition at the least first cost and with a minimum of maintenance expense. In his desire to obtain the best possible results from an investment by a community for good roads or streets, the highway engineer sometimes is inclined to develop rigid specifications for both materials and construction. In some instances clauses devised by other prominent engineers or material companies are suggested as a certain control over some factor in the work or over some of the materials. Such clauses, with others, may be included in the specification and other personally developed tests for controlling materials may be added to complete a specification that is designed to be as nearly fool-proof as possible.

Probably the greatest variation in controlling tests for materials occurs in asphalt cement specifications. A recent study of several asphalt-construction specifications from eastern cities, counties, states and other smaller units of government shows that in thirty specifications for asphalt-cement or sheet-asphalt construction there is a total of twenty-two different tests: in twenty-six specifications for asphalt-concrete there is a total of twenty-four different tests and in thirteen asphalt-macadam specifications there are twenty-two different tests.

These are tests different in character. Where the numerical limit for the same test differs, it is not included as a different test, as the traffic or other conditions may be such as to necessitate a change in the limits. In the total number of specifications for the three types of asphalt construction, there are thirty tests wholly different in character and object. Certainly the same tests, with proper changes in numerical limits should control the quality of the asphalt cement for either of the three types of construction. If specifications for asphalt filler for granite or vitrified block pavement had been included in the above, the number of different tests would have been augmented considerably.

A number of these tests are no more nor less than identification tests, others are of no value whatever and still others apparently weaken the specification instead of strengthening it. Occasionally a requirement is found in the specification that cannot possibly be met if the other requirements are complied with. It is an impracticable task for an asphalt manufacturer to produce enough different grades of asphalt to meet all of the tests or even alter their regular grades to conform with them. When this is attempted it usually results in a material inferior to the regular product. The result is an asphalt that complies with the specification but one that may not run as uniform as the regular grade and one that in many cases has had a good characteristic impaired to produce the condition called for in the unusual specification.

It is true that the various asphalts on the market vary somewhat, due to the source of the crude or the method of refining, or both; but the recognized better grades of asphalts will all meet the proper tests which really control the quality of the asphalt cement. Thus, with a short concise specification, fair competition can be obtained from the reliable manufacturers of asphalt, and in case their product in any particular shipment is cracked or too soft or is wrong in some other important respect, it can be determined by the essential controlling tests. This is accomplished not by identification or irrelevant tests but by the few simple controlling tests included in the modern truly competitive specifications. By increasing the limits of a test or tests in the specification a desirable material not previously admitted can be included without impairing the value of the other products already admitted.

The American Society for Municipal Improvements, the U. S. Bureau of Public Roads, the American Society of Civil Engineers and others have been working for some time toward the standardization of asphalt specifications. In the specifications finally adopted by the first two mentioned, there are no superfluous tests. The American Society of Civil Engineers have largely confined their efforts up to the present time in standardizing the methods of conducting the various tests.

There are three basic characteristics a good asphalt cement for paving purposes must possess:

1st. It must be of proper consistency.

2nd. It must be cementitious.

3rd. It must have stability or permanency of character.

In addition to the three basic characteristics, other important requirements are purity, homogeneity, resiliency and uniformity. The properties required of a good asphalt paving-cement can be controlled completely by a few of what might be termed essential tests, a list of which with a brief description of their purpose follows.

Solubility in CS_2: To determine the per cent. of purity of the asphalt or its total bitumen content.

Flash Point: This is principally a precautionary test to prevent shipment of asphalt that might flash at a temperature usually used in heating the asphalt. A low flash indicates either a cutback asphalt or one made from a crude from which all the light oils have not been expelled.

Melting Point: This test has been included in many specifications to insure obtaining an asphalt that can be easily handled at a reasonable temperature from storage tanks and in heating kettles. It is a fact however that in many instances the melting-point test does not accomplish this. The melting point gives little information in regard to the fluidity of asphalt at working temperature and a much better test to determine the fluidity or workability of the heated asphalt is the viscosity at 250°F or 300°F. The melting-point test is also used to prevent shipment of blown material of low ductility when ductility test is not included, as in U. S. Bureau of Public Roads specifications.

Penetration: To determine the hardness or consistency of the asphalt. By changing the limits of the penetration test at 77°F., a proper consistency for different classes of traffic is obtained. The penetration is taken at 32°F., and 115°F., to determine the susceptibility of the asphalt to temperature changes. It is very important to have an asphalt that does not vary excessively in penetration between 32°F., and 115°F., as this will insure physical stability in the finished pavement.

Loss on Evaporation: An accelerated exposure test.

Penetration After Evaporation: The penetration test at 77°F., 32°F and 115°F., after prolonged heating at high temperature gives an indication of changes that may take place with age at ordinary temperatures. This test also determines the character of the material after it is subjected to heat similar to that necessary in heating the asphalt and the mixture at the plant.

Specific Gravity: Not altogether necessary but used as a gage of uniformity and in determining weight of bulk shipments.

Ductility: To insure cohesion in the asphalt cement, stickiness and non-brittleness. Too high ductility generally indicates a reduction in the resiliency of the asphalt. On the other hand an asphalt of too low a ductility lacks cementitiousness and, therefore, is not a satisfactory binder.

Homogeneity and Freedom from Water: To insure uniformity of physical composition thruout and to prevent water which would cause foaming in heating the asphalt.

Every highway engineer has a theory in regard to asphalt cement and the proper tests for control.

Perhaps in the above it would be well to include the *Solubility in CCl_4* to determine the carbenes or possible cracking in refining, but this test is not now considered a necessity. The solubility in naphtha to determine the relative proportion of petrolenes and asphaltenes is not now generally considered a desirable test as the variation in the gravity of naphtha seriously affects the results of the test and it has been found almost impossible to standardize.

The ductility test is generally considered necessary altho it has not been included in the U. S. Bureau of Public Roads specification.

The Boro of Manhattan, New York city, found the susceptibility test, as explained above under penetration, of great value, and unquestionably this has important part in controlling the character of the asphalt cement supplied this Boro.

Some or all of these last mentioned tests, however, can be and are sometimes used, by properly fixing the limits, to close specifications for a certain brand of material. Other common tests used for identification and closing specifications for certain brands of material are: *Per cent. of Paraffine Scale: Per cent. of Sulphur; Solubility in Ethyl Ether and Fixed Carbon.* None of the above are strictly necessary if the other proper tests are included in the specification. The per cent. of sulphur and solubility in ethyl ether are absolutely unnecessary, as in the case of the former the sulphur has no effect on the asphalt and the solubility in ethyl ether shows nothing at all; simply identifies certain products. Often the ductility clause is made an excessive minimum, thus eliminating certain asphalts that have proven entirely satisfactory for paving purposes. A very high ductility material is apt to be sensitive to temperature changes and usually lacks resiliency, an important adjunct of a good paving asphalt. On the other hand, to a certain extent, too low ductility indicates low cementing value. A reasonable ductility and a low differential of consistency between 32°F. and 115°F. indicates an asphalt cement that will produce a most satisfactory pavement when properly combined with the aggregate.

The field of asphalt construction is rapidly increasing. We hear now of asphaltic concrete bases, asphalt mastic cushion for brick and block pavements and many other new forms of asphalt construction. These new types of asphalt construction together with the increased use of the standard types of asphalt pavements have been responsible for the introduction of many new asphalt-cement specifications and the time is ripe for a concentrated co-ordinate effort on the part of the various engineering societies, the Bureau of Public Roads and the engineering press in standardizing asphalt-pavement specifications and securing their uniform adoption. The engineering societies and the Asphalt Association have started action in this direction and this society particularly is to be commended on the work already accomplished along this line. What we need now is co-ordination and co-operation by the other societies, the Government and the engineering press in completing the standardization and giving the movement the necessary publicity.

It is quite obvious that the work of the U. S. Bureau of Public Roads and the societies that are working toward standard specifications is of the greatest importance, not only to highway engineers but to the asphalt industry.

The specifications of the American Society for Municipal Improvements covering asphalt pavement construction are concise and contain only essential tests which would insure a high-grade asphalt-cement, are not closed to any good asphalts, and have not superfluous clauses. They certainly could be used as the fundamental from which general standard asphalt-pavement specifications could be developed and accepted by the other interested engineering societies and the Bureau of Public Roads.

Already the American Society for Municipal Improvements specifications have been adopted as standard by many municipalities and if the members of this society will actively and enthusiastically work for their adoption in their own localities it won't be long before these specifications will be the recognized standard of this country and will of necessity compel the co-operation of all other interested societies, public offices and the engineering profession generally.

PRESENT STATUS OF MACADAM BASE FOR BITUMINOUS PAVEMENTS

By Julius Adler, Deputy Chief, Bureau of Highways, Philadelphia, Pa.

There has recently been a marked revival of discussion devoted either partly or exclusively to the value of macadam and bituminous concrete as foundations for use under asphalt pavements of various types. While the two kinds of base mentioned have some points of similarity, there are essential points of difference, and what follows has reference only to macadam and closely related types. An analysis of these discussions shows the following advantages claimed for this type of construction:

1. Economy in utilizing existing macadam pavements.

2. Lower cost (depending upon available materials, labor rates, etc.) of construction of new macadam base as compared to portland-cement concrete.

3. Freedom from the transverse cracks which develop in bituminous surfaces on portland-cement concrete, due to the contraction and cracking of that type of base.

4. Slight resiliency of the macadam base, which reduces the hammering or anvil effect produced upon an asphalt surface laid on an unyielding base.

A considerable number of the statements above referred to have issued from disinterested sources and the following quotation from an article by a city engineer of a Southern town is fairly typical of the view point of those advocating the use of macadam and similar foundations, either old or newly constructed:

"From long experience and observation of the behavior of bituminous pavements laid both over a concrete base and over a well constructed macadam base, this Department has concluded to abandon the use of the concrete base for bitulithic and other types of bituminous pavements. The reason for this conclusion is that bitulithic actually stays put on a macadam base very much better than on concrete. . . . A properly prepared macadam foundation is quite elastic. It absorbs a considerable portion of the shock of heavy auto-trucks and does not throw the entire burden of impact upon the wearing surface. . . . Use is made of the old macadam roadway surface to the fullest practical extent. The grades and crowns for the new pavement are adjusted so as to disturb the old macadam roadway bed as little as possible."

Numerous quotations similar to this could be drawn from both printed and verbal discussions by engineers to illustrate the same point, and examples too numerous to mention are cited of the successful use of bituminous pavements on this type of base from Southern Canada to Florida.

In contrast to this viewpoint is the growing tendency in some localities to disregard the possible value of the macadam road for use as a base, the explanation usually being that it is inadequate under all-year-round heavy motor-truck traffic. In such localities the macadam road is perhaps, without exaggeration, regarded as a sort of necessary evil, the best examples to be maintained by bituminous surface treatments until conditions permit of removal and complete replacement by a new type of construction, while those less acceptable are replaced as speedily as conditions permit. In support of this position are the reports from a number of localities of serious damage to both macadam roads proper and macadam-base types during the winter of 1919–20.

Between these two opposite and extreme viewpoints there must undoubtedly be a proper course of action dependent upon a number of conditions and taking into consideration both immediate and ultimate economy in expenditures. Obviously, with the great extent of territory in which macadam roads may be found, with the wide variation in climatic conditions, and in volume and weight of traffic (both of the latter frequently occurring within a comparatively limited area), broad statements in regard either to the merit or lack of merit of a given type of pavement should be made with caution, since they may too often be based upon strictly local examples of construction whose success or failure may have been attributable to strictly local conditions.

The solution of the problem of determining the limitations of a given type of paving construction lies in first establishing the factors affecting its strength and durability, and second the application of these factors to a specific case of proposed construction, the latter, it must be admitted, being very often a difficult matter.

In the present case these factors are as follows:

1. Strength of the base.
2. Variation in supporting power of the earth sub-grade.
3. Volume and weight of traffic.

Strength of Base. Under this heading are included such elements as (a) total depth and degree of consolidation of the base, (b) the size of the units used as aggregate, and (c) the strength and durability of the aggregate.

In the matter of depth of base it is of course generally recognized that other things being equal the greater the depth the greater the area to which a given load is transmitted.

Degree of consolidation, as an item under strength of base, refers to the thoroness with which the pieces of aggregate have been pounded into place during the process of construction and especially by the action of traffic. In this connection it is generally conceded that macadam which has actually carried traffic, if only for a comparatively short period of time, is more reliable from the standpoint of consolidation than that which has been compressed only by means of a roller.

Under size of units of aggregate there must be considered the relative value of a base consisting of small pieces of stone, say 1½-inch in diameter and less, of one consisting chiefly of coarse or ballast-sized stone, and finally of a base in which large pieces are employed, such as the Telford type, or the stone sub-base frequently used in New England, New York and elsewhere.

Results in general point very clearly to the greater value of the base employing the largest possible size of aggregate, affording as it does greater stability and better distribution of loads, freer drainage and less disturbance by frost action.

Under strength and durability of the aggregate is considered the quality of the material composing the aggregate itself. Extremely soft, shaly or rotten stone and very porous grades of sandstone and similar materials will, in course of time, disintegrate under combined traffic and frost action. In general, however, it is pretty well established that no such degrees of hardness and toughness is required for the base material as for the aggregate composing the wearing surface.

Variation in Supporting Power of the Earth Sub-Grade. Observation of failures of macadam foundations shows that in the last analysis this factor is usually the one causing the most serious damage. The supporting power of the sub-grade is evidently affected primarily by the character of the soil, by the natural and artificial provisions for drainage and by climatic conditions, including the amount of rain and snow-fall, depth of frost-action and likelihood of alternate freezing and thawing.

In past years, when the well-built macadam road might have been called the most approved type for all but city use, examples of its surprising beam strength, with sub-grade support removed, were frequently discovered. For present-day traffic conditions, however, wherever motor-trucks are using the roads, the beam strength of the usual macadam base must be considered as nearly negligible; in other words, there must be reasonable assurance of nearly uniform sub-grade support for any except possibly foundations made up of a considerable depth of large or Telford-size stone.

The character of the soil is clearly all-important in this connection. Free-draining sandy and gravelly soils form, as is generally understood, vastly better sub-grade than retentive clay soil, and in certain localities there astonishing examples of extremely light macadam bases laid on free-draining sub-grade of the sort referred to, and carrying considerable traffic with entire success. Where the location of the road and character of the soil are such that natural drainage is poor, all forms of artificial drainage should be provided. Every discussion on proper road construction has from time immemorial included a statement in regard to the prime necessity of good drainage, while at the same time conceding that it is a sadly neglected feature. Whatever may have been the necessity for proper drainage under the traffic of the past, it was never half so essential as it is under the heavy loads of today. That considerable improvement in the uniformity of supporting power of the sub-grade can be effected by thoro provision for artificial drainage, is definitely established, and in many cases a macadam base now giving unsatisfactory service can be made entirely satisfactory. This will undoubtedly leave a small percentage of extreme cases where poorly-drained heavy-clay soil-conditions in flat sections subject to severe frost action will represent a combination of circumstances under which the average macadam base will have insufficient strength under heavy traffic units, even tho the prevailing methods of sub-drainage are provided. Such conditions, however, are likely to prove a severe test of the strength of any type of base of ordinary strength or thickness.

Alternate freezing and thawing, resulting in the condition of soft, thawed-out layers over-lying hard frozen ones, together with the usual heaving effects, etc., produce a very serious lack of uniformity of supporting power unless the sub-grade can be kept nearly dry thruout the winter.

In contrast with this condition there may be cited numerous examples of roads preserved in localities where after winter has once set in, the temperature remains uniformly low enough to keep the earth in a frozen condition, thus preserving its supporting strength, and eliminating the possibility of the percolation of water into the soil during this period. When this condition prevails, the critical time for the base is limited to the period during the spring, when the frost leaves the ground, and the danger of breaking up is consequently much reduced, as compared to the roads which are subjected to the possibility of several alternate freezing and thawing periods during a single winter.

Volume and Weight of Traffic. Traffic records over the past five to ten years, especially in thickly populated sections and near large cities, show enormous increases in the volume of traffic over trunk-line highways. Accompanying this increase in volume of traffic has been the much more serious matter of increase in weight of the traffic unit, resulting in the use of many of our old roads by concentrated loads several times greater than the heaviest experienced in former years.

From the standpoint of the integrity of the macadam base, probably the most important point is that of the likelihood of the use of the road by the loads in question thruout the year. In rather cold, mountainous or thinly populated sections where the traffic practically disappears thru the winter, and does not reappear in quantity until well on into spring, at a period when the subgrade is pretty well dried out, the damage by this type of traffic to the macadam foundation may be relatively slight, while in general the most severe damage is found in localities where the heavy motor-truck uses the roads thruout the year, and more especially during the months of February, March and April.

Suggestions for Improvement. Assuming the foregoing outline to be a correct analysis of the elements which affect and limit the strength of the macadam and similar types of foundation, the problem remains of applying these factors to an individual case, and attempting to determine in advance which ones would be apt to seriously affect the strength and thus limit the life of the foundation and the overlying pavements.

Since each of these elements will vary with every individual case, only general suggestions and recommendations can be made to aid in their application.

In the matter of strength, it will be found that recent recommendations as to the minimum permissible depth of a base of this type vary from as low as four to as high as twelve inches, depending somewhat on individual opinion as well as upon the soil and drainage conditions, etc., affecting the given piece of work. In general there has been a decided tendency to overestimate the depth of existing bases, arising largely from the belief that the annual practice of "dumping stone" on the road over a period of years has resulted in building up a very considerable depth, and failing to take into consideration the fact that usually an equal amount was removed by traffic. This, of course, suggests that, in the use of old roads, a careful survey of the depth of the road should be made by means of test holes, giving an idea, not only of the depth, but also of the character of the aggregate making up the road bed. Examinations of this sort will show many old roads containing an average depth of 6 to 8 inches (in some localities, much more) of compacted stone, these being the ones that are well worth saving. In general, no radical view should be adopted as to the least thickness of base which will support the proposed pavement, since there are few localities in the northern half of the country, and especially near large cities, where a total depth of base of 4 to 6 inches (as sometimes recommended) will be sufficient. The writer believes, however, that even where an ample depth of stone is found, it is usually desirable on old roads to add a uniform layer of ballast-sized aggregate which will serve to elevate the proposed bituminous pavement above the level of the old base which, due to the large amount of dust and fine material usually contained, is very apt to hold a considerable amount of moisture in its capillary voids at certain periods in the year. The objection usually offered to this is the danger of disturbance of the old consolidated road; and while in general this principle is undoubtedly correct, on the other hand the old road which will not stand disturbance for the depth of two or three inches required for scarifying, before the addition of a new layer, will generally not be adequate in depth for use as a foundation in any case. Furthermore, the greater regularity of contour of the base to which a complete new layer of aggregate has been added, will be found to more than off-set in the life of the bituminous pavement the original advantage of paving over a slightly better consolidated, but irregular base, which is apt to produce a pavement of irregular contour. Finally, consolidation can usually be completed by admitting traffic, under restriction, over the completed base.

In the matter of drainage, or supporting power of sub-grade, a very considerable improvement over the existing conditions could be looked for from the adoption of the principle that in the utilization of existing macadam as a base for bituminous pavement, at least as much provision should be made for drainage as tho an entirely new piece of road were to be built over the same character of sub-grade. This, however, is not generally done. Too frequently shallow ditches, ditches too close to the improved surface, sections requiring special drainage, etc., are apt to be allowed to remain without improvement. Recent reports from England are to the effect that macadam foundations under bituminous pavements are giving entirely satisfactory service, due to systematic attention to and improvement in drainage conditions.

One type of failure of the macadam base has been the squeezing out and breaking up of the sides, due to combination of too little lateral support at the shoulders, the softening of the sub-grade under the edges of the pavement due to the entrance of water, and in general, failure to recognize that the sides of the road are frequently thinner and weaker than the central portion. As one means of overcoming this condition, it is believed that the thoroly consolidated base of full depth should always extend at least 1½ to 2 feet beyond the edge of the pavement laid upon it. If the improved surface is of reasonable and adequate width to accommodate traffic, it will then be found that the thrust on the foundation from heavy, slow-moving loads travelling on the sides of the road will meet with much greater resistance than is now encountered. If, however, the improved road is so narrow that heavy traffic is constantly cutting off and on, damage will naturally continue to result.

As a further step toward improvement, some means of waterproofing the shoulders, at the same time furnishing support at the edges of the bituminous pavement, should be provided. Cases have been noted where the existence of an old macadam shoulder even tho rather thin, has been of material benefit. Well-built stone block or rubble gutters and headers produce a similar result. If no better provision is to be made, all stone removed from the old surface should be used to harden the shoulders, and additional aggregate brought in where required.

One of the best practices in this connection on country roads consists in the construction of bituminous macadam wings three or more feet in width, providing water-proofing and lateral support to the pavement, and at the same time furnishing a hardened surface capable of carrying an occasional load. At the least, however, there should be along each edge of the pavement a strip of hardened surface having the same width as the 1½ to 2-ft. extensions of the base previously referred to.

This recommendation may be criticized on the basis that it calls for the construction of a road of a greater width, with a consequent reduction in economy, than would be required if some other type of construction were used, but in its support may be said that the change from an approved width of perhaps 15 feet for two lines of traffic, only a few years ago, to the present situation, where 20 feet is frequently mentioned as a desirable width, points unmistakably to the necessity for providing ample width at the outset on roads near large centers of population. It may further be added that there is reason for believing that many roads of other types built to widths of 16 and 18 feet will eventually need protecting wings, not only for the accommodation of additional traffic, but the preservation of the pavement, as well, since at best a sudden drop-off from a hard surface to a soft earth or clay shoulder, is objectionable from several standpoints.

In a number of instances, the depth of the ditch and its distance from the edge of the improved surface appear to play an important part in the strength of the macadam foundation. If too close to the edge, open ditches allow moisture to get under the edges of the base and reduce the support; if far away, leaving a wide unwaterproofed shoulder, there is too much opportunity for the entrance of water thru the surface, especially at times when the ground is heavily blanketed with snow or ice. The absence of these pervious shoulders is noticeably beneficial in city and suburban streets paved from curb to curb. It is therefore believed that for country roads a shoulder about 5 or 6 feet wide, with provisions for waterproofing between the edge of the road and a point near the edge of the ditch, represents the most desirable arrangement.

To summarize the foregoing discussion, it is believed that proper preliminary studies will make it possible to determine those cases where a macadam base for a bituminous pavement would at best be positively inadequate, and the steps which will be necessary in all other cases to place them in proper condition for use; that (in contrast to the old desire to make use of the macadam with as little expenditure as possible) greater attention to and provisions for proper drainage and thickness, admitting the present limitations to the knowledge of the matter of drainage, will in a large proportion of cases establish the desirability and economy of utilizing existing macadam as a foundation for bituminous pavements.

DISCUSSION

GEO. C. WARREN (by letter): I am very pleased to note that this subject is realized to be of such vast importance that it is separately treated in two papers before this Convention by Mr. Julius Adler and Colonel R. Keith Compton. While confessing to be one of those who from the first and during the past ten years has broadly and persistently urged and successfully practised to a very large extent the great economic conservation value of old macadam roads as a foundation for stable bituminous surfaces, I believe I am not one who has not appreciated and not expressed caution of its limitation.

Of course the so-called macadam must be either *real* macadam of either stone or gravel and of substantial strength and depth or it must be reinforced with new stone added to and compressed into the old macadam. A small percentage of stone or gravel in a large percentage of clay or other weak material is not macadam. Nor is a road which some one may call macadam (but which in reality is merely a thin veneer of indifferently spread stone on a weak subsoil) a suitable foundation for any street pavement wearing surface without substantial reinforcement by the addition of new metal. On the other hand in nearly all cases where any compressed stone or gravel has been spread and compressed on the sub-grade there is at least a great salvage value which should be conserved.

In city streets, especially those having street railroads, it is necessary, in some cases, to remove some of the old macadam to provide against too shallow gutter at the curb or too high a pavement surface grade at the railroad track. In most city streets, however, none of these conditions arise if the engineer will as closely as practicable follow the original contour and will not provide an exposed face of curb higher than is necessary to take care of surface drainage. In most cases a few additional catch-basins may be necessary to reduce the flow of surface water in the gutter, but they can be provided at only a fraction of the waste necessary to remove the old macadam, either as a whole or in part.

In country road construction almost universally the necessary slight raising of the elevation of the pavement surface is advantageous and not detrimental. In other words, the higher the road surface is above the surrounding country, the better the drainage and more successful the pavement, whatever its foundation or surface construction may be.

A few rules may be laid down, to wit:—

1. Never depend on surface appearance nor even test excavation made a few weeks or months before construction to determine whether or not the old macadam will require reinforcement.

2. Always make test holes or better test cuts across the street or road at intervals of say 100 ft. immediately in advance of con-

struction and from those test observations come to an intelligent conclusion as to the necessity for a depth of new metal required to provide the necessary strength of base, which will doubtless vary on different sections of the same project. The quantity of new metal, if any, cannot be definitely determined in advance. Consequently, such reinforcement should be paid for per ton or cubic yard of new material actually used and bids taken on that basis. It is wasteful to attempt to determine and specify in advance of construction how many, if any, inches of new metal is necessary over the entire road. Even if test excavations are made in advance of preparation of plans and specifications preparatory to letting a contract, traffic may very materially change the condition before the construction period has arrived.

3. Do not disturb the old macadam for change of grade or contour or by scarifying unless absolutely necessary. Any such disturbance more or less reduces the strength and consequently the conservation value of the old macadam and sometimes actually removes practically all of it in the center of the road.

If the crown is excessively high, better correct by building up the quarter and outer edges with new metal than to remove solid road metal from the center unless there is a greater depth of solid macadam in the center than is necessary.

4. In every case where there is any road metal on the street, however thin or weak it may be, it is better to leave it in place and conserve it for all it is worth than to remove it, especially in these times of high costs of labor and materials.

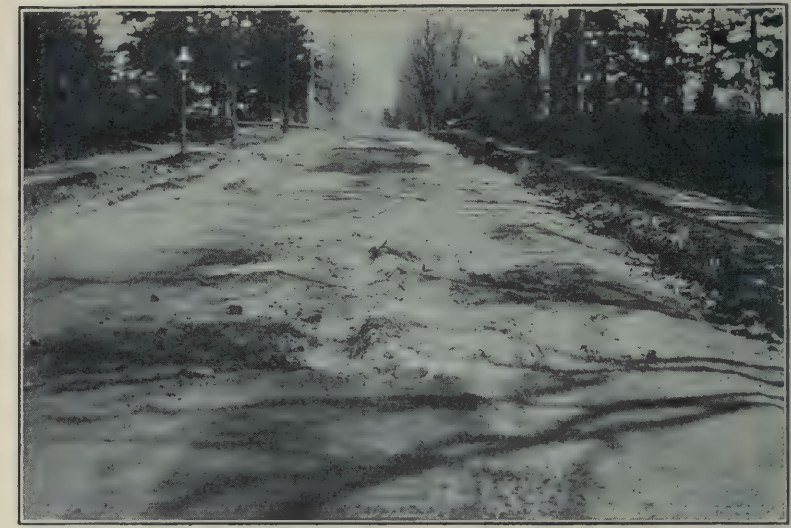
5. If such test excavation as recommended in rule 1 above develops six inches or more of solid metal (whether gravel or crushed stone) in which the coarse particles (ranging from one-fourth inch to two inches or more in size) are more than one-half the total metal so that the finer particles merely fill the voids, then no treatment is necessary nor advisable except to regulate the grade, knocking off the high and filling up the low places by scarifying, picks in the roller, or hand picks, as may be most economical in each case, and then thoroly roll the thus-prepared base.

6. If such tests show that the fine particles predominate or the depth is insufficient on the whole or any part of the macadam road or street, that condition does not justify excavation and wasting of the material, but just add to the old surface, after regulating its grade, whatever depth of new metal intelligent consideration of all the conditions indicates is best and safe. It will surely be much less labor and much less costly than to remove the old metal and supply an entirely new base.

7. If the drainage is poor it should be corrected. A greater depth or more rigid type of base does not correct faulty drainage, some engineers (and many material producers who wish to sell new materials) to the contrary notwithstanding. On the other

hand faulty drainage can be corrected at much lower cost than by destroying the old macadam and furnishing new foundation.

Before the A.S.M.I. and at other times and places, I have repeatedly made a statement to the effect that "from the days of John MacAdam down, the first thing practically every writer on road construction has said is 'drain' but it is the one thing that most engineers fail to consider or intelligently practise in preparing plans." I believe this engineering shortcoming is only somewhat less potent at this time than it was ten years ago. Specific reference to drainage is made in Colonel Compton's paper. This failure to provide drainage is the prime cause of failures which bring out such statements as that of Mr. Adler in his paper now under discussion, as follows:



1. RESULT OF POOR DRAINAGE

Asphalt block pavement laid on six-inch portland cement concrete base. The workmanship on this contract was of the best in every respect. The trouble is due to insufficient drainage and not to type of wearing surface nor base.

Note that the road-bed is several inches below the adjoining property, a condition which in itself always tends to contribute to drainage trouble.

"Macadam types were similarly damaged in some localities during the past winter and, in at least some of these places, there is a growing tendency to disregard the possible value of these roads and the investment in them."

This disaster during the past winter or rather spring thaws was not at all confined to roads, the foundations of which were of macadam types nor to any special type or types of surface. In fact the trouble was universal thruout New England, New York, etc., in places where drainage had been ignored or was faulty. The past winter was unusually severe in those sections, including protracted cold; excessive snowfall and sudden spring thaws. The accompanying illustration of a type of block pavement-surface on portland-cement-concrete base is sufficient to illustrate the point. No one who examined the condition would fairly charge the destruction to either the type of surface or base. It was simply faulty drainage.

Note that, without curbing, the road surface is several inches below the abutting land, a condition which itself always invites drainage disaster, as it provides no outlet for surface drainage except to seep under the road. During that period (early spring of 1920) I had occasion to examine a road which had exploded for a length of about a mile. It was a rolling country and the middle of the damaged section was a sump, formed by long grades ascending in both directions. Of course this is a condition requiring most careful consideration of drainage, but none had been practised and the consequent damage in one week's thaw in that one mile was about $20,000. Not only was no sub-surface drainage provided, but a telephone conduit had been put thru the street without even installing lateral drains or weep holes for escape of water, which it should have been anticipated would likely accumulate in the conduit. For most of the distance the roadway was several feet above the abutting land, so that lateral drainage from the conduit would have been very simple and inexpensive. As a result of this oversight, during the thaw of last spring the telephone conduit became filled with water from sub-surface drainage and overflowed thru the manholes.

It has been suggested that macadam base is applicable for block pavement. While confessing to no practical experience in this connection, I would advise against such practise until its sufficiency has been proved by several years' broad practical experience under varying conditions. My fear is that the irregularities of surface would prove disastrous. Surely the blocks could not be laid directly on the macadam, as is the practise in laying bituminous surfaces. If the blocks are laid on a cushion of portland-cement mortar over the macadam, the thin cushion would probably break up from traffic over the completed pavement. A sand-cushion on the other hand would be more or less irregular in depth and probably cause the blocks to rock and settle inequally under traffic.

Attention should also be called to the importance of stability of bituminous mixture especially in connection with macadam bases. As an example of practical comparative experience,—Commonwealth avenue, from Arlington street to Brookline avenue, Boston, was surfaced in 1915 with Warrenite-Bitulithic laid over the old macadam without any new metal. This section of Commonwealth avenue is the leading thorofare and carries the greatest volume of traffic in the city. Traffic records during twelve hours (7 A.M. to 7 P.M.) show the following:

Saturday, October 2, 1920	13,316 vehicles
Tuesday, " 5, 1920	14,120 "
Average per day (12 hours)	13,718 "

No repairs in five years since laid and the present contour and surface are as perfect as could be. Two years later the section of Commonwealth avenue to the Boston-Newton line, subjected to much less traffic, was improved by a fine aggregate asphaltic surface laid over the old macadam, and the surface is already quite badly undulated.

2. *Commonwealth Avenue, Boston, Looking West from Dartmouth Street. Warrenite-Bitulithic Pavement Surfaced Over Old Macadam in 1916. Photograph Taken Oct. 5, 1920.*

The specifications embodied in Col. Compton's paper suggest that after other preparation of the old macadam, a layer of crushed stone should be spread over and rolled into the old macadam "to form a coarse, grainy surface of fresh clean stone which will bond the bituminous paving material." Our quite extensive experience from the Atlantic to the Pacific (Commonwealth avenue above cited is one instance, and the three 8-mile approaches from Portland, Ore., to Columbia river highway another instance) brings the conclusion that such treatment is quite unnecessary and that the real test of requirement of new metal should be the one of depth and solidity of the old macadam as above outlined in some detail.

ASPHALTIC PAVEMENT CONSTRUCTION ON ILLINOIS STATE HIGHWAY AND CHICAGO BOULEVARD LINK

By John B. Hittell, District Engineer, The Asphalt Association, Chicago, Ill.

For purposes of comparison and perhaps future study it was thought of possible interest to the members of the Society to present a brief description of two asphaltic types of construction recently designed and constructed or under construction and each of which will have, according to belief, a large amount of traffic.

While there is nothing exceptionally distinct in the designs from the usual, yet there is this that in one case a rather unusually rich mix was used in the cement foundation, and in the other an attempt was made to secure a "stiff" top-mixture.

The highway or road type was selected because it is the only one, as far as the writer knows, which was contracted for by the Illinois Highway Department during 1919, the other because it is part of the $15,000,000 Boulevard Link Improvement and hence very likely to be recognized by many at once; the one suburban with unrestricted traffic of unknown amount and sparsely policed, the other metropolitan with restricted but intense traffic, which at times is all it can carry. Asphaltic concrete and sheet asphalt with binder courses of equal thickness are placed against each other and future study may throw some important light on the relative value of these paving surfaces.

ASPHALTIC CONCRETE

It is the custom of the State Highway Department of Illinois to call for bids on alternate types of construction, viz., portland-cement concrete and bituminous concrete pavements; specifying that the latter, with a wearing surface two or three inches in thickness, shall be laid on the same mix of concrete as the cement pavement, with the exception that the concrete for the foundation shall be one inch less in thickness than that specified for the concrete pavement.

In 1919 bids were called for Sections A, B, C, and D of project four, Federal Aid, on what is known as the Chicago, Waukegan and Milwaukee Road, lying in Cook and Lake Counties, roughly three miles in the former and seventeen miles in the latter. The R. F. Conway Co. of Chicago, a firm of ample capital and large experience in the construction of all classes of street pavements, and successful in completing several concrete road contracts with the Department, was awarded the contracts on Sections A and B for asphaltic concrete and C and D for cement concrete. The asphalt bids were about $7,200 per mile greater than those for cement concrete. Undoubtedly the authorities in charge desired to avail themselves of an opportunity to make a fair comparison between bituminous and cement-concrete highway construction, as the conditions were ideal, the same soil, traffic, widths of roadway, a thoroly equipped and experienced contractor, and the fact that the asphalt would connect at each end with a cement road.

As its name implies, the project when completed will furnish a road connecting the manufacturing cities of Chicago, Waukegan and Milwaukee, and very likely is destined to a heavy traffic.

Section A at the south end of the job comprises 48,507 square yards of pavement, and Section B, which is contiguous, comprises 36,929 square yards, and they jointly extend a distance of almost eight miles. To avoid repetition hereafter Sections A and B will be spoken of as the road and is the only part in consideration in this article.

The road commences at the village of Techny and runs northwesterly thru the villages of Shermerville, Deerfield and Everett. At Techny it connects with a cement-concrete road which is eighteen feet in width, seven inches in thickness at the sides and eight inches in the center; mix 1-2-3½.

The road extends thru typical Illinois farming country and in part was an old macadam highway, with the exception of a stretch of about three miles running from Deerfield to Everett, which is a new location thru farm lands. The old macadam was of varying widths and in all instances less than that of the finished road, and on account of the cut is practically of no material value as a support for the pavement. The soil thruout is of clay and drainage is similar to that of other roads built in the State, consisting of side ditches, cross culverts, etc.

During the process of grading long stretches of light cutting were encountered and to facilitate this a large Koehring grader was employed with the result that the operations at times reached the point where three-yard wagons were loaded at the rate of seventy-five per hour. At the end of one of the cuts, where a three-foot fill was made, the soil was such that horses mired themselves and were unable to move their loads. This was overcome successfully by employing a large caterpillar tractor to which were attached three wagons.

In the first part of 1920 a central mixing plant, consisting of two four-bag mixers, was installed for mixing concrete, which was then hauled in trucks for a distance of two and one-half miles and deposited on the grade. This system proved successful during the early stages of the work but had to be abandoned later owing to the inability of the material producers to supply the quantity of materials necessary to operate the mixers simultaneously.

At the present writing (August, 1920) concrete is being laid south from the village of Everett. The materials for the concrete are hauled in bodies mounted on Ford chassis, a body being sufficiently large to contain one batch of four bags of cement, sand, and stone in the proportions of 1-2-3½. The truck is first loaded with four bags of cement from the pile or car, then to the sand car where the sand has been previously shoveled into a box attached to the side of the car from which it is emptied into the truck. This box is readily moved from one point to another on the side of the car, and is sized to hold twice the portion of cement. The necessary amount of coarse aggregate is added and is gaged by the size of the body. About twenty-five of these trucks are employed, and being equipped with 4½-inch tires on the rear wheels, very materially help to compact the subgrade. In fact the District Engineer of the State Highway Department advised me that there is practically no rolling of the fine grade. The line and grade is maintained by steel forms and exact subgrade secured by a strike-board drawn along the same. The condition of the sub-grade is excellent.

The concrete is six inches at the sides and seven inches at the center and the difference makes the crown for the finished pavement. On tangent lines the subgrade is flat. The State 1920 specifications call for cement-concrete pavements to be uniformly 8 inches in thickness with a crowned subgrade, and 7-inch foundation for bituminous pavements.

On curves the superelevation is as follows—the width being eighteen feet.

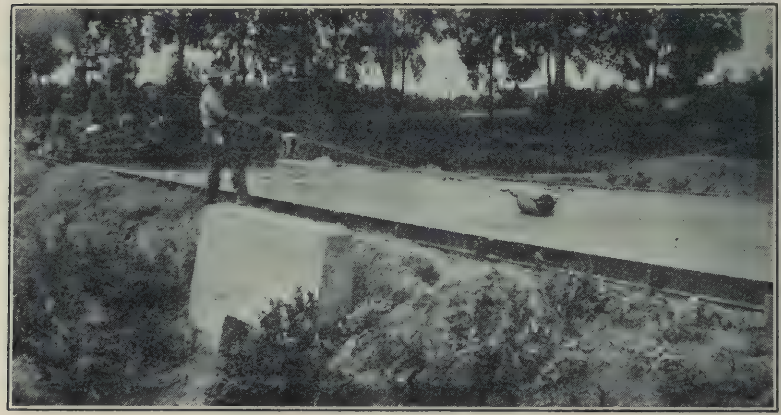
Deg.	Min.	Inches
6	30	15
6		13¾
5	30	12⅜
5		11¼
4	30	10⅛
4		8¾
3	30	7⅜
3		5⅞
2	30	4⅜
2		2½

The rise on curves of 7° (about 800 ft. radius) or less, is 1 inch per foot of width.

The maximum gradient is not over 3 percent, except at bridge approaches where it is 4½ percent.

The concrete at the time observed was not as stiff as might be expected but the inspector explained this was due to the excessively hot day and the fact that the gravel was running a trifle small. With a change of gravel this condition was remedied. A Lakewood mechanical tamper has been used but at the time stated compression was obtained by a large wooden tamper operated by two men, one at each side of the roadway.

In the specifications originally no curb was provided for the bituminous surface, but wisely thru an agreement between the contractor and officials a curb 4 inches in width and about 3 inches in height is being built integrally with the foundation. The height is a trifle less than 3 inches in order that the wearing course may be thoroly compacted at the edge of the curb. The average progress of the concrete foundation with curbing is over 400 feet per day. Last fall when the work was first started brooms were used to roughen the surface of the concrete, but this method was very shortly superseded by the hand roller shown in the photograph. This roller was designed by Mr. G. N. Lamb, district engineer of the State Highway Department, and consists essentially of 5 feet of ten-inch wrought-iron pipe sealed at both ends, to which has been attached at intervals of 5 inches ordinary one-inch angle-irons. Roller is operated by two men, one on each side of the roadway and corrugations are made roughly at an angle of about 60^{c} both to the right and left of the center line of the road, leaving the surface marked in roughly diamond-shape. The result is very satisfactory. Curing of the concrete is secured by the use of wetted tarpaulins and flooding afterwards. No earth is used for this purpose as it is not considered possible to remove it afterwards from the rough concrete in a satisfactory manner.



1. *Roller and Method of Operating to Roughen Concrete Base for Bituminous Pavement*

Four thousand feet of finished roadway was laid in 1919, the concrete was started on Sept. 24, while the binder and top was laid during the week of Nov. 20. Owing to the lateness of the season the contractor ran these materials from his Elston Ave., plant in Chicago, hauling it in 7½-ton trucks a distance of 17 miles. The penetration varied between 56 and 68. Inspection was made by the State at the plant, on the work, and by its laboratory at Springfield.

To finish this year more than 7 miles of binder and top the contractor has installed at Deerfield a 1-car Cummer plant of capacity of approximately 200 tons or 700 linear feet of completed bituminous work. The hauling will average 2 miles. Two tanks of about 18,000 gallons capacity, one for fuel oil and one for asphalt cement, will be used to guard against intermittent supply of these materials.

The specifications gave the bidder the latitude of selecting an asphalt of any of the well known brands as well as tar for the bituminous cement, and the option of bidding with or without a binder course. He chose the binder course and bid on an asphalt meeting the following requirements:

Specific gravity 25°C./25°C. (77°F./77°F.)	1.020 to 1.060
Flash point	not less than 177°C. (350°F.)
Ductility at 25°C. (77°F.)	not less than 100 cm.
Penetration at 25°C. (77°F.), 100 gm., 5 sec	55 to 75.
Loss at 163°C. (325°F.), 5 hours	not over 2.0%
Penetration of residue at 25°C. (77°F.), 100 gm., 5 sec.	not less than 30.
Total bitumen	not less than 99.5%
Per cent of total bitumen insoluble in 86°B. naptha	15.0 to 29.0
Fixed carbon	9.0% to 17.0%

The mixture for the binder course shall be composed of asphaltic cement or tar, stone chips and fine aggregate. The materials shall be so combined that the mixture shall contain average proportions by weight as follows:

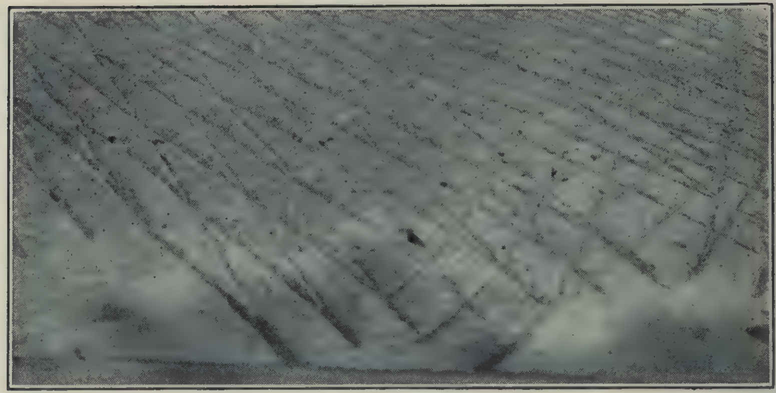
Bitumen	4¼% to 6¼%
Mineral passing 10-mesh	15% to 30%
Mineral passing 2-mesh and retained on 10-mesh	40% to 70%
Mineral passing 1-mesh and retained on 2-mesh	10% to 30%

The mixture for the wearing course shall be composed of coarse aggregate, fine aggregate, filler and asphaltic cement or tar. The materials shall be so combined that the mixture shall contain average proportions by weight as follows:

Bitumen	7¼% to 9%
Mineral passing 200-mesh	7% to 10%
Mineral passing 40-mesh and retained in 200-mesh	20% to 30%
Mineral passing 10-mesh and retained on 40-mesh	25% to 35%
Mineral passing 4-mesh and retained on 10-mesh	8% to 22%
Mineral passing 2-mesh and retained on 4-mesh	0% to 10%
Mineral passing 2-mesh and retained on 10-mesh	18% to 32%

No guarantee is required.

The construction of this asphaltic road and the connecting cement road by the same contractor, and under conditions as equal as can be had, will give an exceptional and excellent opportunity for the observation of the effect which different factors have upon the life and service of a pavement. Many engineers believe that this foundation is needlessly expensive.



2. *Roughened Concrete Surface on Which to Lay Bituminous Wearing Surface*

TRAFFIC NOTES

The beginning of the road is 19 miles from the City Hall in Chicago. On Sunday Aug. 8 and Monday following, Mr. Geo. A. Quinlan, County Superintendent of Highways, took a count of the traffic on Milwaukee ave., between Dempster st. and Ballard road, a point located fifteen miles from the City Hall. The results are as follows:

Sunday

Time	Pleasure cars	Motor Trucks	Total	Weather
12 p. m. to 1 a. m.	130	7	137	Fair
1 a. m. to 2 a. m.	43	2	45	"
2 a. m. to 3 a. m.	160	2	162	Cloudy
3 a. m. to 4 a. m.	142	2	144	"
4 a. m. to 5 a. m.	66	....	66	Rain
5 a. m. to 6 a. m.	78	....	78	"
6 a. m. to 7 a. m.	40	....	40	Clear
7 a. m. to 8 a. m.	280	20	300	"
8 a. m. to 9 a. m.	200	11	211	"
9 a. m. to 10 a. m.	391	28	419	"
10 a. m. to 11 a. m.	567	63	630	Fair
11 a. m. to 12 n.	500	45	545	"
12 n. to 1 p. m.	500	51	551	"
1 p. m. to 2 p. m.	394	19	413	"
2 p. m. to 3 p. m.	513	17	530	"
3 p. m. to 4 p. m.	757	16	773	"
4 p. m. to 5 p. m.	1000	15	1015	"
5 p. m. to 6 p. m.	1027	29	1056	"
6 p. m. to 7 p. m.	1126	45	1171	"
7 p. m. to 8 p. m.	1207	70	1277	"
8 p. m. to 9 p. m.	1148	61	1209	"
9 p. m. to 10 p. m.	709	23	732	Clear
10 p. m. to 11 p. m.	294	11	305	"
11 p. m. to 12 m.	179	3	182	
Grand total.........	....	....	11,991	

Monday

Time	Pleasure cars	Motor Trucks	Total	Weather
12 m. to 1 a. m.	86	2	88	Fair
1 a. m. to 2 a. m.	28	1	29	“
2 a. m. to 3 a. m.	18	....	18	“
3 a. m. to 4 a. m.	23	2	25	Cloudy
4 a. m. to 5 a. m.	34	....	34	“
5 a. m. to 6 a. m.	48	5	53	“
6 a. m. to 7 a. m.	53	7	60	“
7 a. m. to 8 a. m.	135	21	156	“
8 a. m. to 9 a. m.	95	5	100	Fair
9 a. m. to 10 a. m.	121	21	142	“
10 a. m. to 11 a. m.	137	20	157	“
11 a. m. to 12 n.	102	20	122	Cloudy
12 n. to 1 p. m.	93	18	111	
1 p. m. to 2 p. m.	90	13	103	
2 p. m. to 3 p. m.	110	17	127	
3 p. m. to 4 p. m.	110	13	123	
4 p. m. to 5 p. m.	152	19	171	Part Cloudy
5 p. m. to 6 p. m.	168	27	195	Cloudy
6 p. m. to 7 p. m.	102	19	121	“
7 p. m. to 8 p. m.	203	20	223	“
8 p. m. to 9 p. m.	288	15	303	“
9 p. m. to 10 p. m.	112	7	119	Clear
10 p. m. to 11 p. m.	86	6	92	“
11 p. m. to 12 m.	48	1	49	“
Grand total..........	....	....	2721	

The percentage of motor-trucks of all vehicles was 5 minus on Sunday and 10 plus on Monday. Neither of these days of the week was probably as good as any of the remaining five to ascertain the amount of truckage, since business is generally suspended on Sunday. Deliveries are usually from the city on Monday's orders, and farm produce is seldom loaded on Sunday for Monday delivery. Percentage of trucks to all motor vehicles is 12.6 per cent in the State and 20.1 per cent in Chicago.

The Illinois motor vehicle law provides what the weights shall be limited as follows:

> "The maximum gross load to be permitted on any axle of any vehicle shall not exceed 16,000 pounds; and the gross weight of any vehicle, including the weight of the vehicle and maximum load, shall not exceed 800 pounds per inch of the average width of tire of the road wheels of such vehicles in actual contact with the surface of the road.
>
> Weight limits fifty per cent above those provided for herein may be permitted by ordinance in cities having a population of more than 20,000, but such increase shall not apply to vehicles when outside the limits of such a city.

Speed Limits

Weight of Vehicles and Load	Pneumatic Tires	Two or More Solid Tires
5,000 lb.	25 miles per hour	20 miles per hour
5,000 lb., not more than 12,000 lb.	20 miles per hour	15 miles per hour
12,000 lb., not more than 15,000 lb.	15 miles per hour	12 miles per hour
More than 15,000 lb.	12 miles per hour	12 miles per hour

Permits may be issued for specially heavy loads or vehicles. When frost is leaving the ground, officials may on a definitely designated highway, prohibit the operations of vehicles having a gross weight, including weight of vehicle and load, of more than 5,000 pounds, by posting notices along such road. The entire time of such embargo shall not exceed forty-five days in any one year.

The County Superintendent of Highways has a force of about 12 men who are assigned to patrol about 200 miles of the most important improved highways in Cook County.

The offenses which occur most frequently are such as a driver keeping his vehicle in the center of the road, vehicles parking on paved highways to make repairs or to purchase vegetables, vehicles turning from the main highway and stopping on a comparatively untraveled cross road with turned off lights, and the usual offenses against speeding and reckless driving. In the springtime when the frost is coming out, particular attention is given to over-loading of trucks, and this menace was very well corrected after a thoro conference among parties interested. This offense is committed chiefly by trucks hauling building material. This hauling is generally done by individuals or firms owning trucks for the large producers of building supplies. The owner is not the responsible party as the driver benefits in pay by handling exceptionally heavy loads. The need of enforcing the law on this point is necessary on account of the condition of the culverts and bridges which have been built for quite a number of years.

SHEET ASPHALT

The sheet asphalt pavement on the north and south approaches to the new Boulevard Link bridge, and laid in connection with the widening and extension of Michigan ave. and Pine st. from Randolph st. to Chicago ave., will be observed by all that have an opportunity and are interested in pavements.

This improvement, consisting of condemnation of lands and buildings on a frontage of ¾ of a mile, adjusting underground facilities, constructing sewers, sidewalks, electrical lines, depressing intersecting streets, building lower and upper level roadways for commercial and pleasure traffic, erecting a double bascule bridge with two leaves, each 175 feet long, is a magnificent credit to all concerned in the work.

The roadways on Michigan ave. and Pine st. formerly were 38 feet in width, and all continuous traffic passing over them crossed Rush st. bridge, which had two roadways, each 17½ feet wide. The roadway of the new bridge is 54 feet wide; the south approach and the north approach roadways are respectively 75 and 80 feet in width.

As soon as rights to the property were obtained and the obstructions removed, work preliminary to paving was commenced. The stretch of paving from Chicago ave. to Ohio st., covering 17,850 square yards, was paved between July 25 and Oct. 15, 1918. The remaining asphalt pavement on the north and south approaches, progress of which was dependent on the iron work, was finished early this year.

The rehabilitation of underground services and installation of new ones, the old basements and sidewalk sub-areas, required special care in preparing a foundation for the pavement, and the specification wisely provided for sand filling where directed by the Board of Local Improvements.

The paving specifications were: Concrete base 8 inches in thickness, mixed in proportion of 1-3-6. Binder course 1½ inches in thickness, composed of stone varying in size from 1 inch downwards, sand and bitumen, resulting in mixture containing 4 to 7 per cent of bitumen, and from 20 to 30 per cent of material passing a 10-mesh screen. The surface mixture and a test of one batch are as follows:

	Specifications	Test	Composition
Bitumen	10–12	10.5	Trinidad 76%
Portland cement and mineral matter passing 200-mesh sieve	15–20	18.0	I. R. C. 24%
Sand passing 80-mesh sieve	20–30	21.6	
Sand passing 40	20–40	38.2	Penetration 40
Sand passing 10	8–20	10.5	
Sand passing 4	5–10	1.2	

The gradient on the approaches is under 2 per cent and most of the work is on a level grade. On level stretch the crown on the 80-foot roadway is 10 inches with a parabolic curve; on gradients this was reduced to 9 inches. The reasons for these flat surfaces probably were to accommodate traffic comfortably near the curb lines, coupled with the assurance that these roadways being boulevards would be kept clean.

Guarantee

It is understood and agreed that all labor and material shall be of such character that the entire work shall be and remain in good condition during the entire period of one year, except that for all pavements the period shall be two years from the acceptance of the work, and the contractor hereby agrees to keep in perfect repair, during such period, the whole of his work, except in cases where the repairs may be rendered necessary by causes clearly beyond his control. The keeping and maintaining of said improvement in continuous good order and condition for the above mentioned period shall include all repairs to be made, or if necessary the entire reconstruction of the work, as said Board of Local Improvements may direct, without any additional charge or cost to the City of Chicago, except as hereinafter provided.

As a basis for the interpretation of the satisfactory condition of the pavement during the period of the guaranty and at the expiration thereof, it is hereby agreed and understood that if the foundation and binder are sound, and the entire wearing surface of the roadway shall possess a minimum thickness of seventy-five (75) per cent of the original specified wearing surface and be in a smooth condition for travel and shall be free from cracks which show indications of disintegration of the wearing surface, it shall be considered as meeting the requirements of the said guaranty.

To enforce this guarantee 5 per cent of the cost of the pavement is retained, upon which interest is paid. One-half is returnable at the expiration of one year.

The improvement was made solely to accommodate pleasure-car traffic between the two sides of the river and to provide separate roadways for commercial traffic to and from the railroad freight yards.

TRAFFIC NOTES

The number of cars is very large and during the rush hours of the morning and evening the entire roadway is covered. Speeds of 25 and 30 miles per hour are common at these times and are not opposed by officers policing the road.

3. *Michigan Boulevard Link North from Ontario Street, Friday, August 20, 1920, 10:30 a. m.*

The Chicago Motor Bus Co. operates a line of busses of two types weighing empty 10,500 and 11,500 pounds, having an allowable ordinance capacity of 50 and 60 persons respectively. Application to use a type carrying 60 passengers and weighing 12,500 pounds has been made to the authorities and one of this class is now operating under temporary permit.

By ordinance the schedule interval, except at midnight, is not more than twenty minutes "or satisfactory service." In fact in the rush at morning and evening intervals it is about 2 minutes and during the rest of the day 10 minutes. The rate of speed ranges from 15 to 20 miles per hour. Genuine co-operation has prevailed among the company's officials and the authorities, with the result that the destructive effect of this traffic on the pavement has been reduced.

Automobile Count at Pearson St. (200 feet north of Chicago Ave.) and North Michigan Ave., Sunday, February 29, 1920

10 a. m. to 7 p. m. Temp. 20°

10 to 11	400
11 “ 12	550
12 “ 1	750
1 “ 2	900
2 “ 3	1,150
3 “ 4	1,150
4 “ 5	1,700
5 “ 6	1,300
6 “ 7	1,100
	9,400

Automobile Count at Lake Shore Drive (N. Michigan Ave.), and Oak St. (1300 ft. North of Chicago Ave.), Sunday, July 25, 1920

12 noon to 7 p. m. Temp. 60°

12 to 1	900
1 “ 2	1,300
2 “ 3	1,700
3 “ 4	2,300
4 “ 5	2,500
5 “ 6	2,100
6 “ 7	1,900
	12,700

The B. F. Goodrich Rubber Co. on Wednesday, August 11, 1920, took a count of the traffic at Michigan ave. and Jackson blvd., a point about six blocks south of Randolph st.

Time	North bound	South bound	Total
7 to 8 a. m.	574	786	1,360
8 “ 9	1,444	1,702	3,146
9 “ 10	1,635	1,668	3,303
10 “ 11	1,655	1,422	3,077
11 “ 12	1,526	1,461	2,987
12 “ 1 p. m.	1,329	1,407	2,736
1 “ 2	1,523	1,521	3,044
2 “ 3	1,556	1,744	3,300
3 “ 4	1,740	1,717	3,457
4 “ 5	1,783	1,845	3,628
5 “ 6	1,942	1,978	3,920
6 “ 7	1,405	1,302	2,707
Total........	18,112	18,553	36,665
Average per hour	1,509	1,546	3,055
Average per minute	25	25	50

The traffic of the rubber-tired motor-truck, heavily loaded and moving rapidly, together with the nearly total abolition of steel-tired vehicles, has changed the wear on roadway surfaces mostly from attrition to distortion under impact. The impact tests now being conducted by the Bureau of Public Roads to determine the amount of impact delivered to road surfaces, and the effect of this impact on different types of surfaces are timely and of great value. With customary speeds and loads these impacts have been shown to be very heavy and pavement surfaces in the future must be made as near uniform as possible and be composed of tough materials. With the cushioning effect of rubber acknowledged, the tests showing the cushioning effect of bituminous paving surfaces will be awaited with great interest.

The curve of number of motor vehicles in the United States, including the District of Columbia, from 1913 to 1919 was practically a straight line. A change from present economic conditions, which is thought imminent, may change the trend of the curve due to a lesser increase in the number of passenger vehicles. Trucks will increase and the truck owner is vitally interested in the construction and preparation of good roads. If he persists, however, in carrying excessive loads at high speed there can be but one result, drastic laws rigidly enforced. The two instances referred to in this article show that cooperation is better at times than legislation. The truck owner is conscious that he is contributing financially in a large way to road construction, and will voice a demand for a type that will make operation and maintenance of truck the most favorable to him.

Surfaces in use to-day may be characterized as rigid, and flexible or resilient. A smooth, flexible, resilient surface reduces the amount of tire wear and the stresses due to motion in the mechanism and structure of the vehicle. When "favorableness to motor vehicles" becomes a factor, as it shortly will, in determining the selection of a type of construction, the bituminous pavements, combining smoothness, flexibility, and resiliency have decided advantages on this score over other types.

For data and information the writer is indebted to Mr. G. N. Lamb, District Engineer of the State Highway Department of Illinois, Mr. Geo. A. Quinlan, Superintendent of Highways, Cook County, Ill., and representatives of the R. F. Conway Co., which are here gratefully acknowledged.

ASPHALT BLOCK PAVEMENTS

By P. S. Thompson, Sales Manager, The Hastings Pavement Co., New York City

The many advantages of a unit-system asphalt pavement were recognized fifty years ago. The first asphalt block manufactured in San Francisco in 1869 was the outcome of an endeavor to combine these advantages with a smooth, durable surface. Results, while naturally crude, were of such a nature as to justify the hope that such a combination could be successfully effected. Efforts were continually made, during the next ten years, to better the processes and product, and material progress was made, particularly in the manipulation of the mixture. About 1880, with the introduction of powerful mechanical presses, it was at once seen that success was at hand. Since that time the development of the industry has been rapid indeed. New and more powerful presses have been repeatedly installed and better processes adopted. It is to be remembered, too, that this development has been at all times influenced and modified by the conditions involved in meeting the requirements of changing traffic conditions on streets and roadways, and also the many industrial uses to which asphalt blocks have been put, such as pier, warehouse and machine-shop floors.

Composition and Manufacture

As to its structure the modern asphalt block is a composition of crushed rock, inorganic dust and asphaltic cement, thoroly and mechanically mixed at a temperature of about 300 degrees F. At this temperature the material goes to press where each block gets the tremendous pressure of 240 tons. After leaving the press the blocks are gradually cooled by a water bath and are ready for use. The time has long since gone by when all blocks were made upon one formula. By a proper variation of the formula blocks may be made to suit any climatic or traffic conditions. Manufactured at a large permanent plant, under laboratory conditions, nothing is left to the uncertainties of manipulation on the street. The blocks are made in the following standard sizes: 4″x8″x1 1/4″ (deep), 5″x12″x2″ (deep), 5″x12″x 2 1/2″ (deep) and 5″x12″x3″ (deep).

It may be well to give here a brief outline of the development of the asphalt block as regards size and depth and method of laying. Previous to 1897 the blocks were made 4″ wide, 12″

long and 5″ deep, and were usually laid on a sand and gravel foundation. From 1897 to 1900 the size of the block was 4″ wide, 12″ long and 4″ deep, and the method of laying was generally a concrete foundation and sand cushion. In 1900 the size of the block was again changed to 5″ wide, 12″ long and 3″ deep, and it was about this time that the method of laying the blocks on a mortar bed, instead of a sand cushion, came into general use. Improvements in the methods of manufacture resulted in the successful production of a 5″x12″x2″ (deep) block in 1908 and later of the 8″x4″x1 1/4″ (deep) block. Following the perfection of the automatic hydraulic press and increased efficiency in manufacturing and laboratory methods constantly improving the quality of the block, the tendency has been to a rapidly increasing use of the thinner blocks. The 4″ deep blocks are now obsolete, and the 5″x12″x3″ (deep) block, altho still manufactured for special uses, comprise less than 10 per cent of the total output of the block industry. The vast majority of the asphalt blocks now laid are 5″x12″x2″ (deep) and 4″x8″x1 1/4″ (deep). The latter bears the trade name of "eightfour," and has been extensively used on shop floors, loading platforms, traffic aisles, etc. The entire clear floor of the United States Navy Dirigible Hangar at Lakehurst, N. J., 28,000 square yards, is to be 1 1/4″ asphalt block. There is no valid reason why the "eightfour"

1. *Laying Eightfour Asphalt Blocks 1¼ Inches Thick on Machine-shop Floor, Waclark Wire Co., Bayway, N. J.*

should not constitute an entirely satisfactory highway surface in a good many localities, and it is regarded as highly probable that in the near future the "eightfour" will be put to such use.

METHOD OF LAYING

Asphalt blocks, where a concrete foundation is used, are laid on a half-inch mortar bed. This serves the double purpose of leveling off any inequalities in the concrete base, and of furnishing a bed for the block. This method has been adopted as standard after prolonged experiment and observation. Asphalt blocks have also been laid successfully on old macadam foundation. In the latter case the blocks are laid on a mortar bed spread over the old macadam which has been scarified and rolled to the proper crown. In Florida and other southern states where conditions are favorable, the blocks are laid directly on the natural sand as a foundation. It is necessary that the sand foundation be held in place by a header curb on both sides of the pavement.

2. *Asphalt Block Street, Hillside Construction*

An example of this type of construction is the new Memorial Boulevard built by Hillsborough County, Florida. This highway is 24 feet wide for the first three miles, then 15 feet wide for the remainder of the 15 miles.

HILLSIDE CONSTRUCTION

There is a recent development of asphalt block street construction to which we wish especially to call attention, and that is asphalt block hillside construction. This type of construction was first laid in Dobbs Ferry, N. Y., in 1916 on a nine per cent grade, and the results are such as to warrant its adoption by municipal engineers. The concrete foundation and mortar bed are laid in the usual manner. The asphalt blocks are laid upon the mortar bed one row at a time, with a one-half-inch wooden strip between each course. The wooden strips are then removed and the joints filled with grout, mixed one to one and one-half.

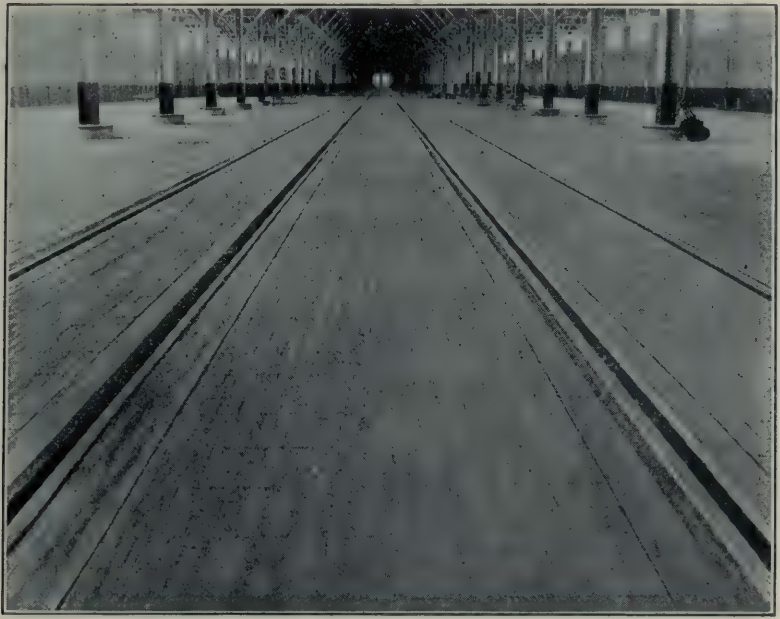
Before the grout has taken its initial set it is scraped out of the joint by means of a special tool to a depth of about one-half inch. The result obtained by this method is a smooth pavement with recessed joints, affording perfect protection against slipping of horses and skidding of motor vehicles.

USE ON PIERS

An interesting development in the use of asphalt blocks is found in their adoption for the surfacing of pier floors. In 1914 the Bush Terminal Company's Pier No. 6,. Brooklyn, said at that time to be the largest pier in the world, and comprising 30,000 square yards on the lower deck, was paved with asphalt blocks. The pier is approximately 1,400′ long by 270′ wide. The two outer ends of the pier, together with a strip about 20′ wide on each side of the pier are paved with blocks laid on the plank decking on a one-inch mortar bed. On the remainder of the pier the blocks were laid on a concrete foundation on a one-half inch mortar bed. Many other large modern piers have since been paved with asphalt blocks, and their use as proper material for the surfacing of pier floors is generally recognized by engineers in and around New York Harbor. Pennsylvania Railroad pier at Greenville, N. J., New York Dock Company piers, Brooklyn, N. Y., Lamport & Holt pier, Hoboken, N. J., New York State Barge Canal piers, New York City, Ocean Steamship Company Terminal, Savannah, Ga., and the Army Supply Base piers, Brooklyn, are all paved with asphalt block. In the case of the several New York Dock Company's piers, the blocks were laid over the plank decking on a mortar bed. Due to the vibration of the planking under heavy traffic, it was found in certain sections that the mortar bed crumbled and sifted thru the joints of the planking. Where that has happened the blocks have been taken up and relaid on a bituminous bed, which has proven entirely satisfactory.

ARMY SUPPLY BASE

Probably the most interesting installation of this type was the Army Supply Base, South Brooklyn, New York. The asphalt blocks laid at the Army Supply Base cover an area of 936,000 square feet. Two standard sizes of blocks were used; 729,000 square feet of the 5″x12″x2″ and 207,000 square feet of the 8″x4″x1 1/4″ blocks. About 585,000 square feet of the 2″ blocks are used for the wearing surface on the lower decks of the four large piers. These piers, which are subject to an enormous amount of traffic, average 1300′ long and 150′ wide with double car-tracks running their entire length. The balance of the 2″ blocks are laid on the loading platforms around the two great warehouses "A" and "B," on the bridges running from the third floor of warehouse "A" to the upper decks of the piers, and on the bridges and in the tunnels connecting the third floors and basements of both warehouses. The bridges and tunnels are divided into two traffic lanes for incoming and outgoing traffic. The 207,000 square feet of 8″x4″x1 1/4″ "eightfour" blocks are laid around the elevators on the third floor of both warehouses and around the elevators and in the traffic aisles of the basement of warehouse "B," also on the shore end of the upper deck of pier No. 4. The method of construction was a reinforced concrete slab on which was laid a half-inch of 1-3 mortar, mixed with just sufficient water to permit the cement to set. This mortar bed was struck to a true and even surface by drawing a light three-inch I-beam over two rows of steel strips set to conform to the desired surface grade. The wearing surface of asphalt blocks was laid directly upon this mortar bed. The blocks were laid with close joints and uniform top surface and required no rolling or ramming. After being laid, the 2″ blocks were given a light coat of sharp, fine sand which was thoroly broomed into the joints. The joints of the "eightfours" were grouted. Because of the congested conditions on the piers, it was necessary to move from one section to another, and to lay around piles of various materials, which was easily accomplished because of the unit system of paving. Most of the work was done during the winter months.



3. *U. S. Army Supply Base, Brooklyn, N. Y. Lower Deck of Pier No. 4, Paved with 2-inch Asphalt Blocks*

One of the interesting features in connection with the work at the Army Supply Base was the special method of handling the blocks, so that from the plant to the place of use practically all hand labor was eliminated, and mechanical devices were designed to do the work. At the plant the blocks were piled in rectangular packages suitable for handling with an elevating transveyor. These packages were placed on the boat by means of a jib crane and tongs. At the Army Base the handling equipment consisted of one electric elevating truck, 20 transveyors and 1,500 wooden platforms. These platforms would hold one package, and were made so that the electric truck or transveyor could run under them and raise them from the ground. On arrival of a scow-load of blocks at the Base, the packages of blocks were placed on the platforms by a scow derrick and tongs. The platforms loaded with blocks were then hoisted on to the pier and by the use of the electric truck and transveyors were taken from this point directly to the layers. This method of handling the blocks proved to be a great saving in time and labor, and helped minimize the effects of the extreme shortage and high price of labor.

4. *U. S. Army Supply Base, Brooklyn, N. Y. Pavement on Top of Garage, North End of Warehouse A, is of 7-inch Asphalt Blocks. Loading Platform at Right is Paved with 1¼-inch (Eightfour) Asphalt Blocks*

VAST TERMINAL PROJECTS

Our experience in the world war has caused us to realize the immediate necessity of better harbor terminal facilities and more improved methods of handling cargoes. This country is now entering on the most extensive terminal construction in its history. The Lehigh Valley Railroad alone has plans for an enormous terminal in New York Harbor which will cover an area of about 635 acres and will include three piers, each seven thousand feet long. New York City has just started the largest steamship pier project in its history. Contracts have been let and work started on twelve new piers at Staten Island, varying in length from 1,000 to 1,160 feet, and in width from 125 to 209 feet.

5. *Transferring Packages of Blocks on Platforms by Crane from Boat to Truck*

The decks of these piers, amounting to approximately 240,000 square yards will be surfaced with 5″x12″x2″ asphalt blocks.

The problems determining the selection of a pier floor are many, and the surfacing material should have the following qualities: Must withstand the grinding and hammering effect of heavy traffic, must not chip or dust, must not be affected by extremes of temperature, must be easy of traction, easy to repair, sanitary, non-absorbent, odorless and free from exudations. The modern asphalt block meets these requirements.

6. *Transferring Packages of Asphalt Blocks in Warehouses by Electric Truck and Transveyor*

In conclusion, the asphalt block is a scientifically prepared product, and the manufacturing formula can readily be varied at the plant for the production of material variously adapted for the surfacing of streets and roadways, floors of piers, warehouses, loading platforms, machine shops, bridges, etc. Experience has demonstrated how asphalt blocks will serve under given conditions, not sometimes, but at all times.

THE PROTECTION OF GRAVEL ROADS BY SURFACE TREATMENTS

By Philip P. Sharples, Manager, Tarvia Department,
The Barrett Company, New York City

The importance of the gravel road problem is realized when the figures for Federal Aid projects are analyzed. For the years 1917, 1918, 1919, 27.67% of the projects called for gravel roads. It was only exceeded by the mileage of earth roads.

Wherever good road-building gravels are available the gravel road is the logical step between an earth road and a macadam type of road. Its usefulness depends on the gravels available, the method of using them, the care taken in providing drainage, climatic conditions, traffic, and above all, maintenance.

During the last few years attempts have been made to utilize the bituminous materials used so successfully in macadam-road maintenance in surface-treating gravel roads. Naturally much of the success of these experiments has depended on the gravel roads chosen for the experiment. As in the early days of macadam treatment, the attempt has been made to save gravel roads which had so far disintegrated that a surface treatment could be of little use, or to treat roads which were gravel only in name and not in fact.

Needless to say, a surface treatment cannot supply drainage, a foundation, or modify a poor construction. Its only office is to protect by a surface skin the structure that lies beneath. If the skin cannot be supported, the road cannot be maintained by surface treatments.

Except in certain localities like New England and parts of Texas, and scattered points in other States where a fund of practical experience has been accumulated, the bituminous treatment of gravel roads may be said to be in the experimental stage.

The importance of surface treatment is everywhere realized. A gravel road, well built of good materials and sufficiently wide to handle the traffic, can take care of 200 vehicles per day without undue stress, if it is well maintained by the patrol system with an intelligent use of the road-scraper and road-drag. With an increase in the intensity of traffic, the dust-nuisance becomes intolerable, and the road develops pot-holes faster than the patrol-men can fill them up.

The surface treatment, if it can be successfully worked, seems to hold out the only hope of holding the gravel road under increased traffic. When the cost of replacing the gravel road with some more resistant type is considered, it will be found that a very considerable annual sum can be expended on a gravel road rather than to spend the money to reconstruct it. According to the type considered, the interest on the new construction, the depreciation, and the upkeep will yield a fund of $2,000 to $4,500, which could well be expended yearly on the gravel road rather than to replace it.

As long as a gravel road is giving reasonable satisfaction with good dragging and patrol maintenance, it should not be surface treated, since the maintenance by surface treatment is more expensive up to a traffic congestion that warrants its use.

Surface treatments should never be attempted unless provision is made beforehand to insure proper patrol or gang maintenance. Their economy and success depend on proper daily care. It is less expensive to let the gravel road go to pieces in the first place than to surface-treat it and then let it go to pieces.

The application of bitumens on gravel may be divided into three groups.

The application of dust-laying oils.

The formation of a bituminous mat.

The formation of a bituminous crust.

The application of dust-laying oils may be resorted to on any type of gravel road. Subsequently, the road is maintained by the ordinary dragging and patrol methods. It must be remembered, however, that the oil destroys the natural bonding quality of the gravel and that in wet weather the oil forms an objectionable greasy mud.

The second method, the formation of a mat of carpet coat with heavy bitumens, either tar or asphalts, is rarely successful, since the mat is not thoroly supported by the gravel surface and quickly breaks under traffic and scales off.

The third method of forming a bituminous crust, which does not form a separate layer but is anchored firmly into the gravel, has given the greatest success. In this work the refined tars used cold have been especially valuable. They penetrate into the gravels easily and harden just sufficiently under traffic to make the process successful. A material that does not harden eventually produces a wavy surface. Such a surface treatment can only be successful on a road capable of sustaining the crust under the traffic conditions imposed. Needless to say it must be built of good gravel, well drained, of proper strength, and of a width adequate for the traffic. Treatments on one track roads are not advisable. If they are adequate for the traffic, they do not need surface treatment. If they are not adequate, they should be widened.

The success of the surface treatment depends so much on the original construction of the road that it may not be out of place to give some of the principles involved.

Gravel in road construction should mean a material containing fragments of stone resulting from natural causes, usually water or glacial action but also in the southern States selection by weathering thru long periods of time.

The stone fragments are usually in a more or less completely rounded form and are particularly valuable in the road, since they generally represent the hardest part of the country rock, since the softer parts have been destroyed in the formation of the gravel.

In selecting gravels for road work, it should be the policy to use deposits that contain 60% of stone held on ½-inch screen and passing a 2-inch screen. The best gravels have the stone well graded in sizes and the part passing the ½-inch screen is also well graded with not more than 15 per cent passing a 200-mesh sieve.

The finer or binding material may be clay, but often fine particles of other rock, like trap rock, make efficient binders. Sometimes iron is present in a form to make a binder. A good index of the binding quality of the gravel is its behavior in the pit. If the gravel stands in a wall it will usually bind in the road. This test does not preclude an excess of clay binder.

Clay and other slime-forming constituents must be at a minimum, not over 15 per cent for roads that are to take a bituminous surface-treatment, since emulsions are formed with the bitumens and the treatment soon sloughs off in wet weather.

If the gravels are not naturally properly sized, changes may be effected by screening to remove an excess either of large or small sizes. The waste may often be utilized in the base. Over clayey soils a layer of fine sandy material will keep the clay from working up into the gravel.

Some gravels are only rendered suitable by washing, but as this is an expensive process, it is not usually possible to resort to it.

Instead of screening out the larger pebbles it is sometimes advantageous to run the whole output of the pit thru a crusher, thus utilizing everything instead of rejecting a large per cent of over-size pebbles. On the New Hampshire gravels this has been signally successful and has added but little to the cost.

As the object in building gravel roads in most localities is to get a road of low cost not greatly in excess of a dirt road, too much modification of the gravel is not justified. Every step in the handling and transportation of the gravel should be carefully thought out and planned. With unmodified gravels the handling and transportation of the gravel are the main items of cost in the road.

The preparation of the road-bed to receive the gravel should be thoro. Drainage, good alinement and proper width should be provided. Gravel roads, it is true, are cheap roads, but satisfaction in their use depends much on making them traversable thruout the year, and safe for all the traffic that goes upon them. Even more than higher-type roads they are dependent on good drainage. A road is only as good as the worst place in it.

The width of the road should be ample. The easy maintenance of the road requires that it should be wide enough to distribute the traffic. Nothing less than 18 feet should be considered for any road that is of importance.

The road-bed may be prepared to receive the gravel either by what is called the trench method or what is called the surface method. In the trench method the gravel is deposited in a trench prepared of the width and depth required of the road. In the surface method the gravel is placed on the leveled surface and allowed to thin out on the shoulders to nothing. A combination of the two methods may also be used.

The surface method has the advantage of better protected shoulders for the same amount of gravel used.

Whatever scheme is adopted, the base should be true to line to ensure a uniform depth of gravel. The gravel should be put in layers not over six inches to the layer. Each layer must be carefully leveled off and consolidated before the succeeding layer is applied. Methods of dumping and handling should be adopted that do not allow the gravel to lie in conical piles that are leveled off. The conical piles segregate the gravel, make it compact unevenly and produce a road that has humps thruout its life.

If different grades of gravel are produced in the pit, the best only should be used in the top layer. The specifications of the A. S. M. I. are explicit on this point, and can well be followed where screened gravels are employed.

The final crown of the road should be about ¾-inch to the foot, but where bituminous treatments are to follow, this should be reduced to ½-inch to the foot. An excessive crown on a bituminous surface tends to slipperiness and is not needed either to compensate for the wear or to shed the water quickly.

The consolidation of the gravel is often left to traffic. The best practice would indicate that rolling is necessary to consolidate the lower layer, and while the final hardening must take place under traffic yet it is much expedited by rolling. The old fashioned horse roller built with sectional rings is particularly useful in this work.

After the road is opened to traffic much care is required. Patrol maintenance should begin at once with dragging or honing after every rain. The end desired is to have the gravel consolidate with the road, retaining the desired shape. If the road is neglected ruts are formed and the gravel is pushed out of shape and even out of the road.

The best way to take care of a gravel road is by good patrol maintenance. A good intelligent man is given control of 3 to 8 miles of road and spends his time under intelligent instruction and supervision in taking care of the stretch. He fills ruts and depressions from store piles of the self same gravel used in constructing the road. He keeps the drainage open. He cuts the weeds and keeps the shoulders up. He drags the road after every rain. In the spring he may receive help with a grader crew to claw his road back into shape after the spring break-up.

Unless the road authorities are prepared to employ such men and encourage them, the citizens cannot expect good roads.

If the traffic becomes so great that there is a dust nuisance, and the patrol man finds it impossible to keep ahead of the pot-holes, the subject of surface treatments should be considered. It is not an easy subject and if no local experience points the way, the advice of those who have successfully worked out the problem should be sought.

The refined tars applied cold have given good results on high-class gravel roads when intelligently applied and when proper maintenance is given. Gravel is not a uniform material and, unless the breaks that occur are taken care of, the treatments are neither economical or successful. The cost will be more than the usual patrol maintenance costs, but the cost of the refined tar is offset to some extent by the elimination of dragging and the saving of wear on the gravel necessitating less frequent renewal. Roads in hilly country are protected from washing with a direct saving and economy after flooding rains.

The gravel roads are prepared for the treatment by shaping and dragging during the spring. If new gravel is added, it should not exceed a depth of two inches and should be added as early in the spring as possible. Heavy additions of gravel should be made in the fall, and new gravel roads should not be treated until they have weathered a winter and been carefully reshaped in the spring.

The road should be treated in the spring as soon as it is firm and solid. In New Hampshire and Maine, the roads are usually ready about the middle of May, but there is considerable seasonable variation.

Sweeping is usually but not always necessary. Only the dust should be removed and care should be taken not to loosen the gravel.

The refined tar is put on cold, or only warmed slightly to 100° or 120° Fahr. The best results are obtained by mechanical sprayers putting on two coats, the first of 0.4 gallon. This is allowed to dry in without cover, which usually takes 6 to 24 hours in dry, sunny weather. The second coat of 0.3 gallon follows. If this is not quickly absorbed, it is covered with just enough coarse, sharp sand or fine gravel to prevent the bitumen from picking up on the vehicle wheels.

After the work is completed, the road should be given careful patrol maintenance. Breaks will develop over soft spots in the gravel, and these must be patched with a mixture of gravel and refined tar. The patrolman should be supplied with 4 to 10 barrels of refined tar per mile at convenient spots for this work. As soon as the first batch of weak spots has been eliminated, a good gravel road requires comparatively little attention even under heavy traffic. Parts of the trunk highway between Portsmouth and Portland carry 2,000–3,000 vehicles per day on this construction.

The treatment usually carries a road thru the winter, but whether it breaks up or not during the spring depends on the road construction, the traffic and the weather conditions. After a hard, snowy winter, the road is not likely to break, but after a soft, open winter, it is quite sure to act like an ordinary gravel road.

If it does not break up, it is given a further treatment of about one-quarter gallon per square yard, and this usually requires cover of sharp sand, or small gravel, using about one cubic yard to 300 square yards of area.

If the road breaks up, it is treated like any other gravel road, shaped up and dragged back into shape. The time when this can be done is short, and it is necessary to work quickly. If the road once hardens, ordinary road machines have little effect on the surface.

The reshaped road is then retreated. Usually ¼ to ½ gallon per square yard will be found sufficient to restore the surface, and carry it thru the season.

Roads that do not in themselves break up may after a few seasons become rough, thru frost displacement or thru poor maintenance. A road becoming rough should be broken up in the spring. The road roller with a steam scarifier is an efficient tool for this purpose. After breaking, the road is harrowed back into shape and re-rolled. It is then given a treatment of refined tar and treated like the road that has broken naturally. The refined tar in the road sticks the gravel together in chunks to some extent, and the road often is smoother and wears better than ever before.

The cost of breaking up is not excessive and in Maine was under $200 per mile for an 18-foot road previous to the war.

The scheme which has been outlined for extending the usefulness of gravel roads must not be misunderstood. It does not produce roads which are capable of standing the punishment of higher class roads. They are not adapted to heavy, all-the-year-round traffic, but they are adapted to a light winter traffic and during the summer will stand up under heavy touring traffic.

Where heavy winter and spring traffic exists, this type of road will not answer, and macadam, bituminous macadam, or even a more expensive type, will prove more economical.

If, however, the gravel road can be made to stand the traffic by an expenditure of even $1,000 to $1,200 per mile per year, it is justifiable, rather than to build a higher type at prevailing prices and high interest rates. A $20,000 per mile type costs yearly in the neighborhood of $2,500 for interest, depreciation and upkeep, and a $40,000 per mile type may be rated at $4,500 per year for the same charges. From these figures, road engineers are justified in giving close study to the problems of the cheaper class of roads. Our road propagandist has made many an engineer forget that even under the most favorable conditions the gravel road mileage built is going to exceed for years to come that of any other type of surfaced road.

TARVIA B SURFACE-TREATED GRAVEL FOR LIGHT TRAFFIC CITY STREETS

By D. B. Davis, City Engineer, Richmond, Ind.

For towns and cities up to 35,000 population a well constructed gravel roadway, surface-treated with tarvia B is a most economical pavement to construct and maintain for residence streets which bear a daily traffic up to 1,000 light-weight vehicles.

Gravel, being perhaps the most plentiful and commonest of all materials for street building, has not as some suppose, had its day of usefulness pass. The recent tremendous increase in the price of other street building materials, due to the increases in freight rates and the labor incident to their preparation for the market has more than anything else caused road engineers to recomprehend its real value.

With its use for residence-street construction proper methods of building should be followed to get satisfactory results. It is not necessary in most cases that elaborate precautions be taken for crushing and screening the gravel unless the proportion of sizes vary considerable from accepted practice. Crushing and screening to sizes add much to its cost thereby eliminating the principal advantages of its use, altho if maximum sizes predominate, it can be run thru the crusher before using. But it is doubtful in all cases whether the screening to sizes for the different courses in the pavement warrants the expense if crushed stone is at all available. Acceptable pavements have been constructed from crushed bank-run or ordinary bank-run gravel from the pit with percentages of binder up to 15%.

Some gravel roadways on minor residence streets were constructed in Richmond, Ind., during 1918 which were surface treated with tarvia B in 1919, which are giving excellent service at the present time. The ordinary methods of construction were used. The old worn gravel surface was first scarified with a 10-ton Huber roller with steam scarifier attached, to a depth of 3 inches. New bank-run gravel was spread thereon to a thickness of about 5 inches. A finished crown of about ½ inch to the foot was attained. After thoro harrowing, the gravel was dampened down and rolled. After once setting it with the roller it was then more thoroly wet and rerolled to a finish. On the final rolling, the surface was brushed by means of a steel brush attached to the roller, this brushing being instrumental in filling the voids of the larger aggregate and to give the surface a smooth pebble-dash finish.

The gravel used in Richmond was from the city's pit and approximated the following screen test:

Passing a 1½-in. screen	100.0%
“ “ 1½- “ “ and retained on ¾-in. screen	11.7%
“ “ ¾- “ “ “ “ “ ½- “ “	6.7%
“ “ ¼- “ “ “ “ “ ¼- “ “	16.9%
“ “ ½- “ “ “ “ “ ⅛- “ “	17.3%
“ “ ¼- “ “ “ “ “ 50 “	29.4%
“ “ 50	4.7%
Clay content	13.3%

The clay appears in this gravel as a coating on the pebbles and not as lumps in the mixture.

Before surface treatments were applied, more satisfactory results have been attained by having the street go thru the winter season, as traffic therefore has an opportunity to help consolidate it.

The preparation of the gravel surface for the application of tarvia B was as follows: First, all depressions of consequence in that part of the surface which had become compact and hard, were repaired and the former contour of the street was restored with a mixture of ¾-inch limestone chips and tarvia X or K-P; then if the gravel surface had had considerable traffic to compact it, it was swept with a rotary broom to a hard surface and all loose material was removed to the gutter with shovels, where it was later removed by wagons after the application of tarvia B. In case the roadway is not thoroly compact, even thru the center, all foreign matter is removed by shovels, but the sweeping is omitted. Sweeping in such a case would loosen the surface particles. Altho it does not mean that poor results will be obtained when the surface particles are loose, it does require additional work and care to get the same results as if the gravel was originally hard and smooth.

When the surface has been prepared, the tarvia B is applied cold by means of a pressure distributer, care being taken that every part of the surface is uniformly covered. For the first treatment from ⅓ to ½ gal. to the square yard was used; subsequent treatments will vary from ¼ to ⅕ gal. per square yard. On the first application no covering is necessary altho for subsequent ones clean chips or pea gravel will add to the endurance of the surface.

Streets which cannot receive a treatment following the initial one should not be treated at all; as it has been demonstrated in Richmond that it requires his second treatment to perfect the surface. Streets whose surface is loose require a second application within one month after the initial one. Failure is sure to result if this is not done. Take where the surface material is not compact and cannot be swept; shortly after the tarvia is applied, traffic will disturb the surface to the extent that at certain places in the roadway the untreated gravel will become exposed and it may even become dusty. After the initial treatment, it is very important to endeavor to distribute the traffic to all points over the street, to iron it out. This has been expedited in Richmond by the placing of signs along the street with the words "Help make a good street. Drive on the side" printed thereon. Whenever the traffic has become general over the entire area, say within a month or so, a second application of ¼ gal. of tarvia B per sq. yd. is applied.

Tarvia B treated gravel streets in Richmond, Ind., have required a minimum of maintenance for the above stated traffic census, altho we find that it is essential to faithfully watch them and repair at once any breaks which may occur. For this purpose, a maintenance patrol gang, consisting of a one-horse wagon with driver and two helpers, is used. In the wagon are carried ¾-in. stone chips and coarse sand in separate compartments; behind, is drawn a tar-heating kettle of tarvia X. The shallow holes or ruts are repaired by pouring a little hot tarvia over the surface and spreading a heavy coating of coarse sand over the tarvia while it is still hot. The deeper holes are filled to within ¼ inch of the surface with ¾-in. chips, smoothed off and tamped, then the hot tarvia X is poured over and around them. One and one-half gallons of tarvia X is used per square yard of patch. Coarse sand is spread over the patch to give it a final finish and make it possible to allow traffic to immediately go upon it.

Should a street after being treated a year or so become subjected to extraordinary traffic or become badly rutted during the winter or spring season; it is scarified, harrowed, reshaped and rerolled as in the original construction. The old tarvia B retains its life and mixes with the gravel to the extent that a crust from 1 to 1½ inch is formed. Soon after, the street is given ¼ gallon per square yard of tarvia B and covered lightly with pea gravel.

Cost of Patching by Patrol Gang Using Tarvia X

Patches of average depth of 1½ inches and average area of 4½ sq. ft.
The gang makes an average of 88 patches in one-half day.

Labor			
5 hours one-horse wagon at 75c per hour	$ 3.75		
10 " 2 helpers at 60c " "	6.00		
		$ 9.75	.025c sq. ft.
Material			
32 cu. ft. stone chips at $2.50 per cu. yd.	2.96		
16 cu. ft. sand at 2.00 per cu. yd.	1.20		
70 gal. tarvia X at 23c per gal.	16.10		
		20.26	.050c sq. ft.
Cost per sq. ft. was .075c		$30.01	

Resurfacing of streets with gravel is done by the street department forces under the direction of the City Engineer and is paid for from the city's general fund. No expense is incurred to the property owners whatever. The cost of re-surfacing with gravel approximates the following:

Cost of Gravel

Cost of bank-run gravel at the pit	$0.50 per cu. yd.
Hauling by teams, 6 loads per day, 1½ yds. per load, team 75c per hour	0.84 " " "
Spreading on street at 50c per hour	0.16 " " "
Extra man at pit loading at 50c per hr.	0.16 " " "
Cost of gravel on street per cu. yd.	$1.66 " " "

Cost of Re-surfacing

Gravel delivered and spread at $1.66. 5-in. finished depth req. .22 cu. yds.	0.37 per sq. yd.
Scarifying and rolling with roller	0.08 " " "
Cost per square yard	$0.45 " " "

The tarvia B is applied by the city forces on petition from the people who reside on the street. A table of estimates is prepared and kept on file by the engineer for tarviating each block of gravel and macadam in the city. This table of estimates shows the width and length of each individual city block, together with the rate of cost per lineal foot and the total cost to the property owners for each block. This amount must be deposited with the city before any work is started.

Engineer's Estimate for Tarvia B Treatment. One application of ¼ gallon per sq. yd.

.003 cu. yds. pea gravel covering at $1.75 per cu. yd.	.005
Tarvia B, f. o. b. track at 12c per gal.	.030
Cleaning and application	.015
Estimate per square yard	.050

As an encouragement to the people, the city has agreed to pay one-third of the cost to the property and all the cost of the intersections.

Table of Estimates for Tarvia B Surface Treatments. One Application ¼ gallon per sq. yd. at 5c

Name of Street	Width of Street	Length of Street	Total Sq. Yd.	Total Cost	⅔ Cost	Rate per lin. foot one side	Rate per lin. foot both sides
N. 9th St. From A to B St.	32.4′	288′	1,037	$51.85	$34.56	$0.06	$0.12
N. 9th St. From B to C St.	32.4′	319′	1,149	$57.45	$38.30	$0.06	$0.12
N. 11th St. From C to D St.	26.0′	257′	743	$37.76	$2 .476	$0.048	$0.09

During the years 1919 and 1920 Richmond has surface treated 245,000 square yards of street surfaces.

It may be of some interest to know of the investigations which have been made by myself and others, concerning treatments of gravel surfaces.

Some treatments of tarvia B were tried out in Richmond, Ind., in 1919 and also in 1920, all to the entire satisfaction of the citizens residing on the particular streets. Being interested to know what the practice was in other localities with this type of construction, questionnaires were sent to engineers and samples of the finished surface and also the original gravel under the surface were requested.

I have listed the answers to the questions received for your consideration. I have also made screen tests on part of the samples submitted. I have taken up the matter of further tests on hardness, cementing, etc., with Prof. W. K. Hatt at Purdue University. He referred the matter to Prof. C. C. Albright, who in part says, "I agree with Mr. Davis that surface-treated gravel roads offer great possibilities in economy of construction and maintenance."

This investigation was decided upon so hastily that data were secured from only a few places and insufficient time has been devoted to it. The answers to questionnaires will nevertheless indicate that there has been some success with this type of construction for light traffic roads and streets. The people of Richmond, Ind., are confident of its success. They are preparing to materially increase their yardage next year.

Following is the questionnaire sent out for information.

GRAVEL ROAD QUESTIONNAIRE

I. Original Construction.
    1. Date and Contractor's name.
    2. What arrangements were made for drainage?
    3. Was road built in one or two layers and how thick?
    4. Was washed or bank-run gravel used? Was it screened?
    5. Was it harrowed to bring coarser stone to top?
    6. Was it water-bound or traffic-bound?
    7. What is its width and crown?
    8. Has analysis of gravel ever been made?
        (a) As to sizes?
        (b) As to character of stone?
        (c) As to character of soil content?
    9. Was it rolled to a finish or dragged?
    10. Was any clay or soil added as a binder?
        (a) How much?
        (b) Was it ferruginous (iron bearing) clay?

II. Maintenance after Construction and Before Treating.
  1. Was regular drag maintenance kept up?
  2. Did gravel pack promptly under dragging or was it loose for awhile?

III. Preparation of Surface for Surface Treating.
  1. Was road swept and how?
  2. Did a rotary broom entirely clean it or was hand work necessary?
  3. Could the road be swept to a hard surface or did the material continually loosen under sweeping?

IV. Surface Treatment and Its Application.
  1. What bituminous material was used? What grade?
  2. How much was applied per square yard?
  3. In one or more applications?
  4. Kind of distributer? Hot or cold?
  5. If surface has been previously treated give approximate dates and amounts used?
  6. How deep did surface treatment mat?
  7. What cover material was used?
  8. Specifications of construction and surface treating are desired if available.

V. What is the general action of surface treatment since applied?
  1. Is a good carpet coat maintained?
  2. Has it been cheaper than drag maintenance?
  3. What is the approximate traffic on the road?

Instructions for Taking Gravel Sample

The sample is to be taken from the traveled roadway where a representative sample of the whole road is assured. The sample shall be taken to a depth of 5 inches unless the sub-soil comes within this depth, when only that material truly representing the gravel content of the road shall be taken.

All material at the surface of the road which is thoroly impregnated with the bitumem shall be included in the sample, but care should be taken to separate it from the balance of the sample by wrapping in paper in such a way that during transit it will not shake in with the balance of the material. A nail keg filled with the gravel, with the surface treated material on top wrapped in heavy paper, is one way to ship this requested sample.

Where convenient and possible, 3 boulders 3 in. in diameter maximum, taken from the material the same as that in the roadway shall be included in this sample—this for the purpose of giving us aggregate of sufficient size to make tests for the French co-efficient hardness, etc.

As brought out by tests made on samples submitted, as to clay content, it seems that success can be attained on gravels which contain as high as 14% of clay.

The sample from Rye, N. H., with a percentage of 13.7 clay closely resembles the gravel used at Richmond, Ind., where the clay content is approximately 13.3 per cent. It will be noticed that the road at Rye, N. H., was too loose to sweep prior to applying the tarvia B; altho the resulting surface is very good as shown by the sample.

Realizing from my own experience that there is a possibility for successful treatments on gravel, I am submitting a tentative specification for your consideration.

Tentative Specification for Bituminous Surface Treatments on Gravel Streets

Preparation of Surface of Road

Prior to the application of the refined tar all depressions in the gravel surface shall be repaired. When thoroly dry, it shall be swept to a hard surface with horse or power-driven brooms or hand brooms of stiff fiber material or both, as directed by the engineer.

Application of Refined Tar

After the surface shall have been cleaned to the satisfaction of the engineer, and when thoroly dry, the refined tar shall be uniformly applied over the prepared surface of the street by means of a pressure distributer as hereinafter described and in accordance with the directions of the engineer. The total amount of refined tar to be used in the construction of the bituminous surface shall be applied in two applications; the first application shall not be less than ¼ nor more than ½ gal. per sq. yd; the second application shall not be less than ½ nor more than ¼ gal. per sq. yd., the precise quantity being determined by the engineer. The second application shall be applied not less than one month or more than three months after the initial one. Prior to the application of the second application, all depressions shall be filled with a mixture of refined tar and clean chips, tamped down, then sealed with refined tar.

Application of gravel or stone covering

No covering will be necessary after the first application. Immediately after the second application, a layer of dry broken stone or pea gravel, not to exceed ⅜ of an inch in thickness, shall be spread and broomed as directed by the engineer over the surface of the refined tar.

Seasonal and Weather Limitations

No refined tar shall be applied when the air temperature in the shade is below 10° C. (50° F.) except by the written permission of the engineer.

GRAVEL: A PLEA FOR COMMON SENSE SPECIFICATIONS

By Wallace F. Purrington, Chemist and Testing Engineer, State Highway Department, Concord, N. H.

In drawing up any specification to cover gravel used in road construction, there are certain facts which must be kept in mind. The foremost question of all is, are the specifications workable? A theoretical specification based on laboratory findings alone may be very impracticable in the field, owing to the fact that the deposit from which the samples were collected is not homogeneous, so that the samples tested do not fully or accurately represent any large part of the deposit. In the second place, specifications may work well or badly according to whether or not the purchaser has the equipment or technical knowledge to check up the different items of composition in the specification.

At the present time most specifications covering gravel are (to the writer's mind) very ambiguous and wholly impracticable to put into operation. Many states make a practice of using screened gravel, but for the expense involved and the results obtained, New Hampshire, and it has many miles of very good gravel road, has found this procedure unnecessary. If the manipulation of run-of-bank gravel is properly supervised, the results obtained are equal to those with the screened material. In the first place, gravel usually is defined as the material passing a 3½-inch screen; then a ¼-inch screen is interposed and two distinct sizes of material are separated. The material retained on the ¼-inch is arbitrarily called gravel or coarse aggregate and the material passing it is called sand or fine aggregate. Specifications commonly attempt to set limits to the ratio of gravel to sand which shall be such as to guard against the gravel being too sandy on the one hand or too cobbly on the other. This might be very satisfactory if gravel deposits were generally uniform and homogeneous in texture, but that is not the case. The gravel deposits which are most abundant and accessible all thru the northern states, deposits left by flooded rivers during the closing stages of the Ice Age, are notably heterogeneous in structure and texture. The long narrow ridges or "eskers" of the New England States, and the shorter, interrupted ridges and hummocks of gravel, called "kames," show abrupt variations in the deposit, from the fine sand to coarse, cobbly gravel, both in vertical section and lengthwise; so that a sample taken at one level or at one point may give a very incorrect idea of the average run of gravel from the face of the bank, and is no guide whatever to the quality of material that will be found 50 or 100 feet farther in. These banks were built by rivers running thru and out from the melting ice sheet, where great floods during warm days or weeks alternated with sudden droughts when severe cold waves checked the wastage of the glacier. This spasmodic behavior of the glacier rivers accounts in large measure for the variability of the material in most "bank" gravels. Even the wash-plains and valley-terrace gravels which accumulated beyond the reach of the ice-sheet show too much variation in texture, both vertically and horizontally, to yield samples that would afford an adequate basis for judgment in the laboratory of what can so readily be seen in the field. A demonstration of this fact, by a study of scores of samples from a single deposit, has been given by Reinecke and Clarke in a paper entitled "The Sampling of Deposits of Road Stone and Gravel in the Field," and published in the Proceedings of the American Society for Testing Materials, Vol. 18, part 2, 1918. Their conclusions were summed up as follows:

"A large variation was found between results of duplicate granulometric laboratory analyses on the same sack of gravel. The variation in texture over one deposit of gravel of 800 acres was found to be large."

An inspection of almost any bank in New Hampshire will illustrate the truth of the foregoing statement, and the futility of depending upon a single sample or many samples to pass judgment on a given deposit. The desired result is far more likely to be gained by making the texture (coarse or fine) and grading (uniform, streaky, etc.) matters for field inspection by the engineer in charge, and leaving the laboratory to test only the resistance-to-wear of the gravel. Assuming then that the material is composed of hard durable stones, the rather overworked phrase, "such as will meet the approval of the engineer," can well be used. This means more for the proper construction of gravel roads than any theoretical grading system that may be adopted.

In New England and the Northern States, three sorts of material usually compose the gravel pavement of a road; gravel, sand, and till (which last is commonly called "hard pan"). According to the proportion in which two or more of these are combined, such roads should be designated as, "sand-gravel," "till-gravel," or "sand-till-gravel" road. The choice as to which type of gravel road is to be built will depend largely upon the material found in the sub-grade. The finer material is added to fill the voids in the coarse aggregate, and acts as a binder. The State, being the purchaser, may well tell the contractor whether clay, till, or sand shall be used. It might also say that the base-course shall be of gravel, the larger stones predominating, and that the wearing or top-course shall be such that much smaller stones shall predominate. This sort of statement is comprehended by all parties interested. The engineer, inspector, contractor, or government representative has an intelligent basis from which to draw conclusions and a far more honest statement than could be obtained by a chance sample showing that 59 or 63% is retained on a ¼-inch screen. Such a specification is not only misleading, it is positively absurd.

The soundness or durability of the stone comprising the aggregate is however a matter of considerable importance. Fortunately, we have a rational method of gaging this in the Rea modification of the DeVal abrasion test as described in the Bureau of Public Roads bulletin No. 555, page 30. By this test it is possible to place certain arbitrary values which ordinarily should not be exceeded.

A few outstanding facts will serve to summarize what has been said concerning gravel specifications: (1) The greatly increased demand by the public for good roads cannot be met in every community by adopting the heavier and more costly types of construction. Gravel and earth roads must still be very generally built, and local materials thus used. As the item of screening of gravel is quite costly we may well consider its elimination, as the question of its efficacy is open to question. (2) Specifications for the material to be put into such gravel roads must be plain and straightforward; so far as grading is covered, the specifications must be based upon what a reliable engineer sees *at the pit* where the deposit is fully exposed, not based upon the laboratory screening test of a sample or a group of samples from a deposit which in all probability varies greatly in texture. (3) A laboratory test of the percent of wear of the coarse aggregate, according to the Rea-DeVal test, should be made a part of the specification, to insure that the material consists of sound, durable stones. (4) The character of the fine aggregate or matrix should be left to the judgment of the engineer. (5) A little theory, mixed with a lot of common sense, is better than the reverse.

With these points in mind, after conducting an extensive field and laboratory survey of gravels, the State of New Hampshire has adopted the following specifications:

MATERIALS FOR GRAVEL PAVEMENT

Gravel is to be understood to be a water-laid, stratified deposit which consists of rolled and rounded stones accompanied by sand and clay in varying proportions. The stones (or coarse aggregate) shall be hard and sound and well assorted, in sizes up to but not exceeding three and one half (3½) inches in long diameter. The resistance to wear shall be determined by the modified abrasion test described in bulletin 555, page 30, of the

U. S. Department of Agriculture, Office of Public Roads; and the gravel thus tested shall be classified as follows:

Class A, Hard gravel under 7 per cent wear.
Class B, Medium hard gravel from 7 to 10 per cent wear.
Class C, Medium soft gravel from 10 to 15 per cent wear.
Class D, Soft gravel above 15 per cent wear.

Classes A and B may be used for either or both base or surface course. Class C will not be used for surface course and gravel of D quality will not be used except by written permission of the Commissioner.

The texture (coarseness or fineness) of the aggregate from any source or supply of gravel shall be such that it shall meet the written approval of the Commissioner. No gravel shall be used until a complete report has been made by the Engineer regarding its qualities, and the approval of the Commissioner has been obtained specifying the class of work for which its use is approved. The approval shall be furnished on a form which shall contain the following information:

1. Account to which work is to be charged...............
   (Town)
2. Nature of material, gravel, sandy gravel, sand, till, clay
3. Source of material....................................
   (Local name) (Location)
4. Type of material, gravel, gravel-till, gravel-clay, sand-clay
5. Contractor or Foreman.............................
   (Name) (Address)
6. Grading of pit (Visual inspection) (Check the description which best fits the case.)
   (a) Uniform and well graded, large stones predominating.
   (b) Uniform and well graded, small stones predominating.
   (c) Streaky or poorly graded, coarse aggregate predominating.
   (d) Streaky or poorly graded, fine aggregate predominating.
   (e) Sandy with only a small amount of coarse aggregate.
   (f) Cobbly with only a small amount of fine aggregate.
7. The Laboratory has reported on a sample submitted from this source under Laboratory Number......to be.... % of wear and is rated as Class........gravel.

....
Engineer

This is satisfactory material and may be used in the base, surface course.

....
Commissioner
By..............................

RECENT EXPERIENCES WITH WOOD BLOCK PAVEMENTS

By Hermann Von Schrenk, Consulting Engineer, St. Louis, Mo.

During the past two years numerous failures of one kind and another have been experienced with wood-block pavements. Following periods of heavy rain-fall during the summer of 1919 and at various times during 1920, wood blocks buckled and heaved and in some instances on long stretches of city streets the blocks floated away entirely. There has also been an increase in the number of cases of failure by decay of supposedly well treated blocks. Cases of excessive bleeding have also been reported, but less frequently than in former years. In addition to the foregoing a case has been reported of blocks shrinking excessively to such an extent that the blocks became loose in the streets. In view of these difficulties, particularly when taken in connection with the difficulty of obtaining both proper timber and creosote oil for the treatment of same, it is possibly not surprising that wood-block paving has dropped somewhat in the estimation of some engineers.

These failures, so far as the writer has been able to examine them, have been due, not so much to any inherent defect of creosoted wood blocks as such, but almost wholly to conditions entirely within the control of the engineer. Many valuable lessons have been learned as a result of these failures and in the following it will be the endeavor of the writer to give a brief analysis of the underlying causes with some suggestions as to how these may be prevented.

Any consideration of wood-block paving may be grouped under five headings:

First, kind of timber to be used,
Second, condition of timber,
Third, preservative to be used,
Fourth, treatment,
Fifth, laying.

In 1916 the Committee on Specifications of the A. S. M. I. adopted specifications for the timber, condition of the timber, the oil to be used in treatment, and the treatment of wood-block paving (see Proceedings 1916, pages 588 to 608). These specifications are in effect today with the exception of certain slight changes in the specification for preservative presented and adopted in 1918 (see Proceedings 1918, page 371). At the 1919 convention, the chairman of the committee on Standard Specifications for Wood-Block Pavements made the statement that these specifications appeared to be satisfactory and would insure a good, substantial lasting block.

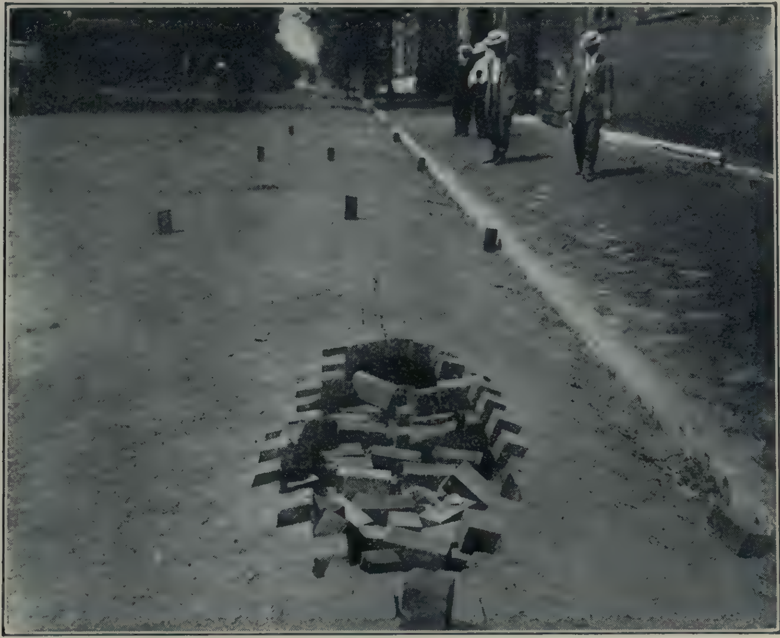
Taking up the individual headings:

Timber.—Where the present specifications of the A. S. M. I. have been followed as to the kind and quality of timber, a reasonably dense, satisfactory block has been obtained and few, if any, failures have been reported because of the character of the wood used. In view of the failure of the sap-wood of treated blocks, the writer has had numerous inquiries as to whether sap-wood after all was not to be treated as a serious defect in a paving block. Sap-wood as such, if sound, has all the strength qualities of heart-wood. You may be interested in the diagram not printed showing relative strength of sap and heart in Douglas fir, from which you will note that practically the weakest wood in the tree is in the center of the heart. The difficulty with sap-wood is in the nature of the treatment rather than because it is sap-wood.

Preservative.—Preservatives used during the last few years, while they have not always been in accordance with the specifications of the A. S. M. I., have been more or less satisfactory and there has been very little complaint. The statement made by the writer before this organization in 1915 that the preservative is not the most important and vital part in a successful wood-block paving holds today as well as it did then. Where a good coal-tar product is used with a fairly high percentage of high-boiling compounds, failures will be few and far between, in fact, the writer has yet to see any failures of blocks due to the oil used where such oil was a pure coal-tar compound.

Treatment.—The treating specifications as at present prescribed have proven satisfactory in every way and there seems to be no reason to ascribe any of the recent failures to treatment.

Condition of Timber.—The present specification provides that "the timber may be either air-seasoned or green, but should preferably be treated within three months from the time it is sawed." Recent experiences indicate that it may possibly be desirable to modify this clause to put a greater emphasis upon the necessity for having timber as thoroly air-seasoned as possible, in other words, with a minimum moisture content. Reference has been made to failures due to decay. In 1915 the writer discussed in considerable detail failures which had taken place in various cities due to the decay of the sap-wood of treated blocks and showed that this decay was due almost entirely to failure to obtain proper sap penetration. The sap decay of creosoted blocks has become more evident, not only on the streets then reported on, but on many new streets. Attention is again called to the fact that proper lasting cannot be obtained unless the blocks are thoroly penetrated with the preservative, meaning by this at least perfect penetration of every part of the sap-wood. Penetration thruout the sap-wood can only be obtained in all cases if the blocks are as dry as possible. There is no question whatever but that many of the failures to obtain complete sap penetration are due to the fact that the blocks were not thoroly dry and that water pockets were still present in the sap-wood, thereby preventing complete penetration of the preservative. There is of course no use for laying a block pavement if one cannot be reasonably certain that it will be so protected against decay as to give the maximum length of life. No amount of steam treatment will make possible equitable distribution of creosote oil in a wet piece of wood. In this connection, it may possibly be of interest to explain that the initial steam treatment of paving blocks is for the purpose, not so much to get rid of water, as to assist in the driving out of the air, which is the principal factor causing bleeding after the blocks are laid in the street. Even if the use of thoroly air-seasoned material did not appear warranted because of conditions to be described presently, it would nevertheless be necessary and desirable to treat air-dry timber for the sole purpose of getting better penetration than has frequently been obtained in the past.



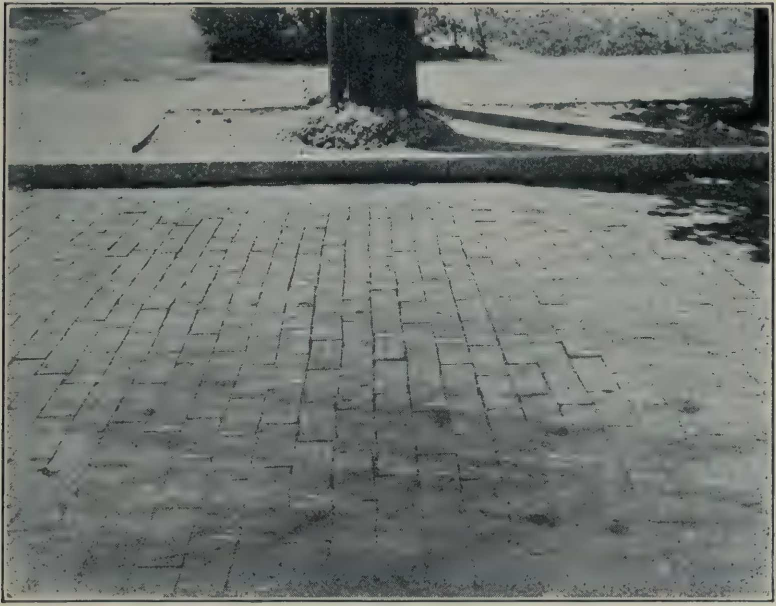
1. *Expansion Troubles in North Eighteenth Street Wood Block Pavement Immediately After Completion. Sand Filler and Sand Cushion*

Inspection.—The present specifications of the A. S. M. I. call for careful inspection of the blocks after treatment by sawing a number of the blocks taken at random at right angles to the fibers thru the center of the block. This is practically the only way in which one can detect the extent of the penetration of the preservative. In view of the sap failures, I strongly urge that this method of inspection be rigidly followed at the time of treatment at all times.

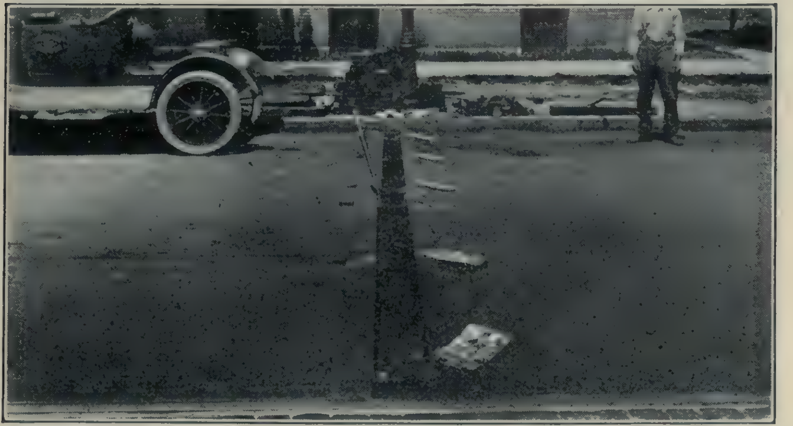
Laying.—By far the largest number of failures of wood block paving in recent times has undoubtedly been due not to the blocks, but to the manner in which they were laid in the street. So much has been written about this subject in the past two years that it will hardly be necessary to more than indicate the present state of our knowledge of this exceedingly important factor. In the early days of laying creosoted wood blocks when more or less rough concrete foundations were used, the sand cushion came into use largely to give a smooth base on which to lay the blocks. During the period of its more extensive use difficulties of all sorts arose. The blocks bulged in spots after rain-falls, and after very heavy rain-falls whole street sections floated away. In many cases curbstones were thrown out of line. Another difficulty occurred, due to the shifting of the sand base giving irregular depressions and frequently holes. It has long been realized that the employment of the sand cushion was largely responsible for the unwelcome swelling and the displacement of curbstone and surface. Water found its way between the individual blocks and was absorbed by the sand at the bottom of the blocks. The latter then swelled more at the bottom than they did at the top, with the resultant disturbances.

It is this unequal swelling of the blocks that has probably been the greatest factor in the failures during the past two years. So common have these local eruptions become that they are considered by some to be a necessary evil in connection with the wood block. In spite of the fact that these experiences are now of many years' standing it is surprising to find how many cities still use the sand cushion, particularly in view of the excellent results obtained in many cities with other methods.

As a result of experiences with the sand cushion, a number of cities adopted the plan of laying blocks directly on the concrete base, either with a thin cushion of sand-cement mortar or frequently on a perfectly smooth concrete base with a bituminous coating. The first street of this sort laid was Dearborn street, Chicago, between Adams and Jackson boulevard, put down in 1914. The east half of the street was laid on a mortar cushion and the west side on a smooth concrete base with a bituminous coating. The writer is indebted to Mr. Gabelman, Engineer of Streets, Chicago, for the following report on this street: "At the present time the west side of Dearborn street from Adams street to Jackson boulevard is in excellent condition with the exception of a couple of cup-holes. Two yards of maintenance would make it perfect. This side of the street is where the heavy trucks unload mail and



2. *Wood Block Pavement on Union Avenue, St. Louis, Mo., Showing the Block Contracted and Loosened in the Early Summer of 1920*



3. *Wood Block Pavement on Union Avenue, St. Louis, Mo., Showing Jack Frames, and the Block Tightened up on Each Side of the Jacks*

should show much more wear than the east side of the street. The east side shows much more wear and is very uneven and is full of depressions." Another street with which the writer is familiar, laid shortly after (1915), is 15th street, St. Louis, between Olive and Washington. This was laid on a concrete base prepared with a smooth finish, painted with pitch and the blocks laid directly on the pitch after it had cooled. It was then rolled with a light steam roller and the joints filled with pitch. This pavement is still in perfect condition and I trust that all of you will take the opportunity to look at it while you are in the city. Very few pavements of this sort were laid, however, until comparatively recently. The abandonment of the sand cushion was followed most frequently with a sand-cement cushion, laid dry and moistened immediately before the laying of the block. In many cases this has not come up to expectations. If the sand was at all moist at the time of laying, a very poor bond was formed and the mixture acted practically like a sand cushion.

With the introduction of the smooth concrete base with a bituminous coating on which the blocks were laid directly, has come another series of problems of an entirely new character. In laying blocks on a sand cushion or on a sand-cement cushion, a filler of some sort was always specified to guard against admission of water between the blocks. Experience has shown, however, that even with the best care there was always sufficient space left to allow the water to percolate to the base of the blocks. Here it would stand for a short time and then be gradually absorbed by the base of the blocks, causing them to swell, with consequent uneven expansion and heaving. With either the sand or sand-cement cushion there is, in other words, a material holding water in immediate contact with the highly absorptive lower surface of the blocks, as distinguished from the bituminous surface, which absolutely prevents water-absorption. In some cases (see Horner, Engineering News-Record, April 22, 1920) the filler when softened under extreme street temperatures, flowed down under the blocks in an irregular manner and increased the chances during sprinkling or rain-storm for water-admission to points immediately underneath the blocks. With the use of a bituminous coating on a smooth concrete base, particularly after the blocks were rolled, an almost water-tight condition obtained at the bottom of the blocks. Explosions after rain-storms such as occurred on previous types of construction happened very rarely, if at all, on the bituminous concrete base. Blocks, in other words, were more or less protected from water on all sides ecxept on the top. The amount of water absorbed on the top by the blocks was very small and usually disappeared rapidly by evaporation after the rain or sprinkling. There was practically no tendency for the blocks to enlarge. On the other hand, it was found in a number of cases that blocks thus protected from water absorption lost the water during periods of high temperatures in summer and tended to become loose. This condition is very elaborately described by

W. W. Horner, Chief Engineer of Paving, St. Louis, in Engineering News-Record, April 22, 1920, page 814. Three streets are described in this article. The blocks were laid on a smooth concrete surface, mopped with pitch at 140° to 145° melting point and the blocks laid after the pitch had cooled. Shortly after laying the blocks contracted and became so loose that they had to be taken up out of the street, cleaned and relaid. On another street laid about the same time, where it was shady and the rate of evaporation of the water from the blocks was very much less, little difficulty was experienced as to shrinkage.

In the current issue of Engineering News-Record, Mr. Horner describes the action of one of the streets last referred to, which had been laid in the summer of 1919 after the relaying of the street first mentioned where the shrinkage had been so high. The blocks in this second street were laid very tight, anticipating a possible shrinkage. In June of this year these blocks began to shrink just as they had on the street first referred to. With an extremely ingenious device, fully described in the paper this week, Mr. Horner took up the shrinkage, which amounted in one case to a total of 1.3 ft. in 125 ft. Your careful attention is directed to the extremely interesting details presented in the paper referred to. After the complete closure of the blocks on this street, with terrific rain-falls coming early in September, there was not the slightest movement of the pavement in any direction. An almost ideal condition has been obtained, namely, blocks were protected against water at the base by the pitch coating, on all sides by the pitch filler, and the tops of the blocks, while not quite as effectively water-proof, absorbed only small quantities of water, which disappeared rapidly after the sun came out. In other words, the heaving effect due to the absorption of water at the base of the block was almost entirely obliterated.

4. *Repaving McPherson Street, St. Louis, Mo., Relaying Clean Wood Blocks on a Quarter-inch Cushion of Barrett's K P in Sand. Note Old Pitch Bed in the Foreground*

The great trouble-breeder with the wood-block paving, aside from the question of bleeding, has been water,—water absorption and water loss. Water-absorption causes expansion which, when it takes place unevenly, as it has done in the cases of the use of sand cushions and frequently sand-cement cushions, brings about upheaval in the pavement and entire destruction of the street during heavy rain-storms. Water-evaporation has caused loose blocks and a constantly disturbed street surface. The ideal condition is one in which the blocks are so prepared that they may have a minimum amount of water in the wood to start with and then to have them so protected that they will have little opportunity for absorbing water. The nearest approach to such a condition will undoubtedly be obtained as indicated by Mr. Horner, by treating as thoroly air-dry timber as can be obtained, then laying the blocks on a smooth concrete foundation with proper pitch surface, taking care to lay the blocks as tight as possible, and then providing a thoroly acceptable pitch filler. This practice is now being followed in some of the newer streets which have been laid in this city, pictures of which are now before you on the screen.

5. *Preparing Concrete Base for Wood Block on Washington Avenue, St. Louis, Mo.*

Summing up the foregoing, experiences of the past few years seem clearly to indicate that the proper procedure to obtain maximum service from wood-block pavements is to follow the specifications for timber, preservative and treatment prescribed by the A. S. M. I., with possible modification to the treatment specification looking toward the treatment of thoroly air-dry timber. This should be followed by blocks laid on a thoroly smooth concrete base with a good pitch coating, blocks laid as tight as possible, with a good pitch filler. When this procedure is followed there seems to be no reason to anticipate any of the difficulties which have worried the street engineer during the past few years, and should once again put this useful material to the forefront in all street construction.

DISCUSSION

Mr. Tillson: I want to say just a few words and that is how very glad I am to have heard such a paper as this from a man who is not only fully conversant with the subject, but who could go over the country and make these different examinations and come back and make a report that would not be biased by anything. Mr. Von Schrenk has not been connected with any city, and would not be biased for or against any particular city. But I want to correct one impression that I am afraid might be drawn from this paper, altho I do not think it was intended, and that is that the first wood blocks were laid on a sand cushion. I know a great many people have that idea and I know it was given in a paper I heard a short time ago in another city. That may be true in the west and in the south. As a matter of fact, the first wood block pavements in the east that were laid under competitive bids, were laid in New York City with a mortar bed, and that plan was used for a good many years, until some engineers seemed to think the sand cushion could be used, and used a little more cheaply. I think in every case where it was tried, they afterwards went back to the mortar bed.

The idea of the mortar bed in the first place was not that it was better than the smooth surface that Mr. Von Schrenk and everybody advocates, and everybody is glad to see at the present time, because in European countries they have always used that system, but I do not believe at that time anyone would have been able to get that sort of specifications adopted, because of the extra cost that would have prevailed.

Now, it is an altogether different proposition. We had no trouble with these sand cushions on mortar bed pavements because the blocks remained smooth, and the last time I saw them they were thirteen or fourteen years old and were in good condition as far as that part of the pavement is concerned.

I simply want to make it clear that the early pavements in the east were laid with a mortar bed.

Mr. Buehler: As the time is getting so late, I really have not the time to discuss more than one point that is brought out by Dr. Von Schrenk which I believe is extremely vital. From the experience here in St. Louis, the conclusion apparently has been drawn that the timber should be thoroly seasoned before it is treated. Those familiar with wood preservation know that without question, in the treatment of ties and timbers, the wood should be thoroly seasoned before treatment, but in the treatment of paving blocks, the experience of a good many years has taught us that it is not proper to treat wood that is thoroly seasoned. The principal reason for that conclusion was the trouble with the block pavements due to expansion.

The conclusion that bituminous-paint-coat construction will so water-proof the block that we can use seasoned timber, seems to be indicated by Dr. Von Schrenk's paper and by the experience here in St. Louis. I seriously question the advisability at this time, of throwing into the discard the experience of a good many years, in respect to the condition of the wood before treatment.

The Doctor brings out the point that the wood must be thoroly treated. I want to call attention to the fact that in the treatment of the paving block (indications are now that treatments will be 10 or 12 pounds instead of 16) they are treated by a process in which a pre-determined amount of oil is forced in and the treatment stops. Southern pine will hold more oil than 10 or 12 pounds to the cubic foot, and if it is thoroly seasoned, most of the oil is going into the sapwood with very little into the hardwood.

I could show the Doctor streets and photographs of streets, where just the opposite condition that he has pointed out has taken place, where the hardwood has rotted out and the sapwood is sound, where the sapwood took all the oil and the hardwood very little.

If the specifications adopted by this Association and the American Wood Preservers' Association are thoroly followed with respect to time of pressure and rate of pressure, I am sure that a good treatment in the sapwood can be obtained. I have seen blocks that were treated green under the specifications, with a thoroly penetrated sapwood.

I want to agree with the Doctor that it is extremely important that the sapwood be thoroly treated, but I want to sound this note of warning—I believe our experience is too limited, with the one case in St. Louis, to throw in the discard our past experience. Anticipating that this question might be brought up, I wrote to about a dozen cities that were using the bituminous-paint-coat construction; among them, Cleveland, Lakewood near Cleveland, Akron, Ohio, Detroit and several others, and in every case where I got a reply, they have had no such experience as St. Louis.

I am of the opinion that the summer in which McPherson street was paved was unusually hot, which no doubt contributed to the difficulty experienced.

The pitch paint coat in connection with this form of construction must be applied as thinly as possible. I have been given the information that the paint coat applied on McPherson street was applied quite heavily and, due to the hot weather, failed to harden before blocks were laid. As a result, it was not possible to lay the blocks close together.

(The following by letter.) I have been informed, also, that a considerable period elapsed between the time the blocks were laid and the application of the pitch filler, which resulted in the opening up of the joints still further, due to shrinkage of the wood in the blocks. The filler, when applied, therefore, was in considerable volume between the blocks and again, due to hot weather, did not harden and ran in under the blocks, resulting in more pitch under the blocks, which eventually ran to the gutters.

Approximately a week following the application of the filler, it was found that the joints between the blocks were very wide and open and a second application of filler was made, which further aggravated the trouble. It is my opinion, therefore, that this particular experience cannot be used as a criterion for conclusions relative to effect of treating green blocks.

I again wish to state that it is my opinion that it is not advisable to change the present standard American Wood Preservers' specifications. I do believe, however, that the experience in St. Louis should not be passed over lightly but should be followed up and taken into consideration in the event that at other points similar difficulty is experienced indicating that the new form of construction, that is, bituminous-paint-coat construction, has introduced a new element, due to its perfect water-proofing properties, which might make changes in the standard specification advisable at some time in the future.

MR. HORNER: I think our experiences and our troubles with wood block in St. Louis have been principally valuable in leading us further towards a technical analysis of the action of the wood in the pavement. It has seemed to me that a sound analysis of the climatic changes which occur, and of their effect on the condition of the wood in the pavement, would indicate that the difficulties met in St. Louis are bound to occur again wherever blocks are exposed to hot summer temperatures for a considerable length of time and in the absence of rains. There seems to be no question that block laid without thoro seasoning are bound to shrink under these conditions, and that we must be prepared to tighten up the pavement whenever the shrinkage takes place. Of course, this question has been brought to our attention thru our direct experience, but an analysis will indicate the probability of recurrence.

DR. VON SCHRENK: Mr. Buehler, if he listened closely, noted I made no recommendation that the specifications be changed, but simply, in view of the experience, that it would be a proper matter for future consideration in discussing this thing. Something has been discovered of a fundamental, technical character, and if it is going to necessitate a changed method of pressure or distribution of oil, that is the easiest thing to change.

I believe, in examining a variable product such as wood blocks, that the nearer we can come to its behavior under all circumstances the nearer we can approach proper conditions of utilization.

A MEMBER: In this case where the blocks shrank so badly, did the blocks on top show indications of shrinking from drying?

MR. HORNER: I am not certain—it was not noticeable.

A MEMBER: Another question, did you apply your filler directly, without putting on sand?

MR. HORNER: Generally the filler poured into the joints was in direct contact with the bitumen of the paint coat. On a considerable part of Union avenue limestone dust was swept into the bottom of the joints before filling. This seemed to have a good effect in retarding the sinking of the pitch during that summer. We found, however, during the second year, that much of this dust had amalgamated with the pitch filler and with the creosote which had bled out of the blocks.

A MEMBER: Did the pitch float your blocks in any instance?

MR. HORNER: The whole pavement was raised.

MR. SOUTHGATE: There is danger in that method. The pitch will surely raise them, surely float them. I have seen it occur where you could step on the block and squeeze the pitch out on a hot day. It would come up. That may occur, but it seems to me it is a wise precaution to use a certain amount—say fill your block about a quarter full, or one-eighth full of dry sand to act as a dam. My experience has been that that stops the floating of the blocks. I have tried that now for four or five years, and where you have that dam at the bottom of the blocks with the dry sand, it prevents the floating.

Touching on the question of the mortar bed, where you have a block pavement where the traffic shifts about and is not confined to a groove as sometimes occurs and occurs frequently on the narrow streets, they stay put very well, but we have instances where they were laid on the mortar bed under rigid inspection, on a street with double track street car lines, automobiles stopping next to the curb, the traffic was confined to a groove, and in all those instances, the mortar bed has failed from crushing, and the blocks have become very uneven, show a marked groove.

The mortar bed should certainly have body or thickness enough to prevent crushing down. If it has not, you are going to have trouble from that source.

MR. KENDRICK: We had some little trouble this year with our wood block pavements. They have been laid about eight years. It was a good job, laid on a sand-cement cushion. We noticed shortly after they were laid, that each block fitted into a little mold, the cement-sand cushion having come up between the blocks and hardened. After the blocks came up this year, we noticed the concrete base was smooth but many of the blocks were broken. We attributed that condition to the pavement having been elevated by expansion a short distance and then, being settled back by traffic, the blocks rested on the edges of the molds and crushed them.

In one instance, in making these repairs, we removed the sand-cement cushion. There was no indication of its having been broken and it was quite difficult to remove. We painted the concrete base with cut-back asphalt cement, then applied a half-inch sand-cushion and dipped the bottom of each block in a bucket of cut-back asphalt just before laying. Examinations later on showed that the asphalt had penetrated the sand (by the way, we used dry sand) and consequently we had as a cushion almost a bituminous concrete.

After the blocks were relaid, they were grouted with hot asphalt cement, but some trouble was found in getting it into the joints, so we mixed cut-back asphalt with it, which penetrated more readily. In other instances we used hot asphalt cement, leaving the sand-cement cushion in and painting it with asphalt cement. In other instances, pitch was so used. We have had several very hard rains since, and have had no trouble.

These troubles usually occurred at the foot of a grade, and in taking up the pavement, even weeks after a rain, there was still water seeping from under the adjacent pavement. Consequently, we cut grooves in the concrete base, parallel to the gutters where the blocks were to be relaid, and connected the grooves with sewer inlets. In some instances it was found advisable to cut such grooves in the concrete base from the gutter grooves or the sewer inlet out to the car tracks to take care of the water which followed along the car tracks beneath the pavement. It has been found that for several weeks after heavy rains, the water is still draining into the sewer inlet thru these grooves.

I am rather inclined to think that in our climate, where we have a great deal of rain and but little freezing weather, it would probably be beneficial to lay a 2-inch drain tile in the concrete base along the gutters, filling around the drain with gravel or similar material, connecting the drain tile with the sewer inlet.

MR. DUTTON: In regard to that, we laid a great many blocks in that way, on bituminous cushions with the pitch filler, and have had no difficulty in holding those blocks. In the first place the bitumen has to be rather thin. Not too much pitch on the foundation, and we fill with the pitch filler, without any sand. You always have difficulty in getting in the right amount of sand. We have had no trouble in holding the blocks.

CONCRETE FOR MUNICIPAL PAVING

By Lt. Col. H. C. Boyden, Portland Cement Association, Chicago, Ill.

Nearly all engineers recognize the necessity for a heavy concrete base under any type of pavement laid in city streets in order to carry the heavy concentrated traffic and to maintain the smooth even surface so desirable for these thorofares. That this need was recognized in the cities long before concrete was used for rural highways is a matter of history and is also evidenced by the fact that prior to 1909 there were 444,864 square yards of unprotected concrete paving in cities as against 34,061 square yards of rural highways.

This does not of course include the concrete base under other types of paving, of the area of which we have no record, but which is undoubtedly much larger than that of the unprotected streets.

It is the increasing weight and demands of the traffic that have brought about this use of concrete base and unprotected paving and in my opinion there is no other material that will carry the traffic of today with the same degree of efficiency.

The success of any type of pavement is absolutely dependent upon the foundation upon which it is laid and too much emphasis cannot be put upon the necessity for exercising the greatest care in studying the existing conditions, designing and building the drainage system and in building up and making a uniform sub-grade. Volumes have been written on this subject and as I believe every man here realizes the value of a well drained, uniform support for a street surface, I shall not take up the time by adding to those writings.

The unfortunate fact remains, however, that, in spite of all that has been written on this vital subject and in spite of the realization of its importance by all engineers, more road- and street-surface failures have been caused by improperly built sub-grades than by any other one phase of construction. There are many causes that contribute to un-uniformity in the bearing power of sub-grades, the principal ones being poorly designed drainage or often times lack of any drainage, insufficient rolling of some soils or excessive rolling of other soils, insufficient scarification of existing macadam or gravel-road surfaces, often times leaving a hog-back in the center of the street with soft shoulders at the sides, old water-pipe or sewer trenches which have been improperly filled in and last but by no means least the constantly varying classes of material encountered in the progress of the work.

Several different classes of materials often occur in less than half a mile of construction, each one of them requiring a different kind of treatment to give it the same bearing power, and yet in the process of grading they may be so mixed up that they receive practically the same treatment when the sub-grade is being finished.

With these contributing causes, it is no wonder that soft areas and hard areas occur in sub-grades, sometimes small and sometimes large in extent and often times close together. In view of this fact, it is absolutely necessary, in order to prevent uneven surface conditions from developing, that the pavement be so constructed as to prevent internal movement in the structure itself and also to have sufficient slab strength to bridge over areas which have less supporting power than adjacent areas.

All pavements are made up of aggregates of various sizes held together into one mass by some kind of a cementing material. The stronger this cementing material is the better will be the pavement, and the less tendency there will be to internal movement in the structure of the pavement itself.

I think you will agree with me that there can be but little slab or bridging strength unless the adhesive power of the cementing material holding the aggregates together is sufficient to prevent this internal movement in the structure of the pavement or base.

There is no cementing material that I know of except portland cement that will prevent this internal movement of the aggregates and thereby hold them into a mass that has slab or beam strength to bridge over the weak spots that will occur in the most carefully built sub-grade.

If there is opportunity for the aggregates composing the street surface to move, the hammer-like impact of the heavy traffic will drive portions of the pavement down into the softer spots in the sub-grade and cause an uneven wearing surface.

If, however, the base or pavement is properly made concrete of a proper thickness, there will be no internal movement of the aggregate, and the structure will have slab or beam strength to distribute this impact over a much wider area of the sub-grade and where the soft areas are not of too great an extent to bridge over them completely.

It has been and is today the custom in some places to build concrete bases under other types of wearing surfaces of too weak a mixture and not of a proper thickness to properly perform the duties put upon it. This has in some cases caused failures that could have been avoided by the exercise of proper care in the design of the mixture and in the execution of the work.

At the November meeting of your society last year, Mr. A. N. Johnson outlined to you the most recent developments in concrete highway construction and there is but little to be added to what he has said. I do want, however, to again emphasize some of the most important precepts that should be followed in order to obtain the greatest strength and wearing qualities in whatever concrete is used.

In connection with the choice of and proportioning of aggregates you are all probably more or less familiar with Prof. Abrams' theories for the design of concrete mixtures using the factor of the fineness-modulus.

Prof. Abrams has this year published a table containing 135 proportions with different combinations of aggregates, which if used with materials acceptable as to quality, will give a concrete with a compressive strength at 28 days of approximately 3,000 lb. per sq. in. All the tests for the determination of the factors in this table were made of a concrete of a workable plasticity, formed into cylinders 6″ x 12″ in size and tested at the end of 28 days.

In conformity with present practice the aggregate is divided in the table into fine and coarse, and covers combinations of five classes of fine aggregates with twenty-seven classes of coarse aggregates.

In order to determine in what class a known aggregate shall be placed, the following rules should be followed: if it is a fine aggregate at least 15 per cent of the total shall be retained on the next smaller sized sieve, if it is a coarse aggregate at least 10 per cent shall be retained in the same manner.

This table shows a considerable reduction in the amount of cement required as compared with previously published tables, especially when combined with the larger sizes of aggregates. As an illustration, the quantities used today for a 1:2:3 mix, with sand up to No. 4 and stone from No. 4 to 1½″ are 1.74 bbls. cement; 0.52 cu. yds. sand and 0.77 cu. yd. of stone, per cu. yd. of concrete. Concrete designed according to Prof. Abrams' table required 1.61 bbls. cement, 0.47 cu. yd. sand and 0.72 cu. yd. stone per cu. yd. of concrete.

These figures are the exact quantities required for the making of one cubic yard of concrete having a strength of 3,000 pounds and if used will effect a very material saving in the cost of concrete roads and pavements.

An allowance for waste, varying for each ingredient and also according to the particular method employed in handling the work, should be added to the quantities given in the table. Professor Abrams is now preparing tables similar to the one already published, for concrete with compressive strengths of 2,000 and 2,500 lbs. per square inch. As soon as these tables are completed they will be published in the technical press.

In connection with the consistency to be used, I want to again impress upon you the advisability of using the consistency that will give not over 1 inch slump when measured with the truncated cone, 4″ at the top, 8″ at the bottom and 12″ in height.

Remember that the addition of one pint of water in a one-bag batch more than is necessary to give a workable plastic mix produces the same loss in strength as if two or three pounds of cement had been left out, therefore the greatest care should be taken to prevent this excess of water from being used.

It is a noteworthy fact that there are concrete bases laid in the days when it was the custom to put in concrete so dry that it had to be tamped in order to flush the water to the surface, which are giving service today, while bases built in later years with an excess of mixing water have failed in a much shorter period of time.

The last step in the process of laying a concrete base or pavement is unfortunately only too often entirely neglected or at best only partly carried out. This step is the curing or protecting the concrete during the early hardening period.

It has been unquestionably proven by Prof. Abrams that by simply keeping the concrete wet for ten days, either by ponding or by covering with wet sand, the compressive strength will be increased 75% and the wearing qualities will be increased by 40%. This increase in both compressive strength and wearing qualities goes on as the time of protection continues up to 21 days, after which time the value of such protection is much less apparent.

It is surely worth this short delay and small expense to double the life and strength of the concrete, especially in view of the fact that all heavy traffic should be kept off of the road for 28 days in order that the concrete may have sufficient time to properly mature.

This delay is often used as an argument against the use of concrete, but there is no question that the results attained by such a delay are more than enough to warrant the inconvenience and expense.

The constant tendency of the traffic passing over our streets and highways is towards heavier unit loads and it is the duty that all engineers owe the people who are putting up the money to provide pavements with that money that will carry these increased loads.

It is certainly poor engineering to use existing traffic as a final measure of the demands to be put upon a pavement without carefully studying this increase curve and providing for at least a normal rate of increase during the estimated life of the pavement.

It has been the custom in the past to build concrete bases, 6, 7 and even 8 inches thick but in recent years there has been a tendency in some places, owing to increased costs and sharp competition among the various types of pavements to cut the thickness down below the 6-inch mark.

Various attempts have been made to justify this cut in thickness by showing that the wearing surfaces add to the bridging or slab strength of the base, but for the reasons given previously it does not seem to me that this is justified to the extent claimed, and I firmly believe that we must rely entirely upon the base to give us the required bridging strength.

Information of value in this connection may be brought out by the series of tests now being made by the Bureau of Public Roads at the U. S. Experimental Farm at Arlington, Va., but up to the present time no conclusions can be drawn from these tests.

In view of this tendency of the traffic towards heavier loads, it would not be advisable to build concrete bases or pavements in any locality less than 6 inches in thickness and in the commercial, manufacturing and congested sections of cities they should be 8 inches or over in thickness.

Thus far in this paper only concrete bases under the various types of wearing surfaces have been considered, but attention is called to the fact that there is a consistently increasing area of unprotected concrete pavements being built in the streets of our cities and towns.

As I have previously stated, prior to 1909 there were 444,864 sq. yd. of unprotected concrete pavements in use in our city streets and this area has increased greatly in the past eleven years, so much so that there are today 55,279,000 sq. yd. of this type of pavement in city and town streets.

This increasing use has been brought about by the realization on the part of many engineers that the need for a wearing surface on properly constructed concrete is a thing of the past, and also by the constantly increasing tendency of the engineers to follow the principles of design and construction as laid down by Prof. Abrams and Mr. A. N. Johnson.

Unprotected concrete street surfaces built of a properly designed concrete mixture, which has been mixed a full sixty seconds, is of a proper consistency when laid, and if kept wet for ten days, or better for twenty-one days, will have a wearing surface that is the equal of and better than many of the expensive wearing surfaces being used in city streets today.

There are many instances of concrete surfaces which have been subjected to heavy traffic for six and seven years that show the original broom-marks made when they were laid. In one case a dog ran across the green concrete of a city pavement and left impressions of his feet one-eighth to one-quarter of an inch in depth. This was in 1913, or seven years ago, and in spite of the fact that a very heavy volume of traffic has passed over this street since that date, running as high as three or four thousand vehicles a day at times, the foot prints are as sharply defined today as when they were made.

These are silent witnesses of the fact that modern traffic does not wear the surface of a well constructed concrete pavement.

In connection with the impact tests mentioned previously, the Bureau of Public Roads is making an abrasion or wear test of various types of road surfaces with unprotected concrete of various mixtures among them.

You are probably all familiar with the method being used in making this test so I will not describe it here but will simply call attention to two facts that I noticed on my last visit to see the tests.

Altho at that time over two thousand trips had been made over the pavements by the heavy cast-iron wheels of the testing machine there had been almost no abrasion of the concrete surfaces.

There was one other thing that was very noticeable. When standing at the shoulder at the side of all the types of pavement except the concrete, the jar of the machine passing over the pavement was distinctly noticeable but there was an absolute absence of this jar when the machine was passing over the concrete.

Thus the smooth hard wearing surface of the concrete pavement saved the sub-grade from the additional impact due to the roughness of the other types of wearing surfaces.

However, altho the concrete pavement has a smooth hard surface it is not slippery even in wet weather, which is a very vital factor when we consider the congested traffic conditions in most of our cities today.

In this city, where there is almost no concrete pavement, there were 494 automobile accidents in March of this year. Of this number 91 accidents were caused by skidding on the wet pavements and there was no other one thing that caused as many accidents with the exception of careless driving. These 91 accidents would not have occurred on concrete pavements.

In conclusion I believe these things may be said in favor of unprotected concrete pavements for city and village streets.

They are cheaper in first cost for the same strength.

They are far cheaper in ultimate cost which, after all, is the real cost.

They have a very low maintenance cost.

They do not require an expensive plant outlay and upkeep for maintenance.

They may be repaired in such a manner as to maintain their original smooth surface.

They do not become slippery in wet weather nor when being cleaned by flushing.

They are easily cleaned.

They are sanitary because they are non-absorbent, are not sticky and have the least number of joints or depressions for the lodging of filth.

They are safer to drive on at night because of their light color.

They have the lowest tractive resistance of all types of surfaces.

PAVING BRICK AND BRICK PAVEMENTS

By J. C. Travilla, Consulting Engineer, Dunn Wire-Cut Lug Brick Co., St. Louis, Mo.

The widespread use of brick pavements, the indefinite policy in the paving brick industry as to sizes and types, public sentiment, and the engineer's preference for particular "standard" designs and construction methods based on local results, make the standardization of paving brick and of brick pavement designs and specifications by no means a simple matter.

The paving-brick industry has had much to contend with recently, thru war restrictions, low production, increased costs of labor and fuel, lack of transportation facilities and the like. This has been reflected in the so-called high cost of brick pavements when competing with other types on the basis of first cost alone, instead of annual costs during the pavement's life. Because of this, brick pavements have sometimes been considered too costly, with the result that business has been restricted. This has caused some unrest among certain manufacturers and may be considered one of the reasons for the request for certain amendments to brick specifications, made by the National Paving Brick Manufacturers' Association at the 1919 meeting of the American Society for Municipal Improvements.

Possibly because of a lack of co-operation or co-ordination in the paving brick industry by limiting the production to a few types, manufacturers are reported to have twelve different styles of brick for paving. No arguments are needed to prove that this situation should be corrected, but who is to be held responsible? Certainly not the engineers. Engineering organizations have been working for years thru special committees to standardize pavement specifications. Their recommendations for brick include two types and they have been adopted generally by municipal and state highway engineers.

Paving-brick manufacturers should realize that they are merchandizing their output thru engineers representing the taxpayers, and that any request to change sizes and types of brick or amend specifications to meet changed conditions affecting the industry should be based on definite technical information proved by experience.

The necessity for modifying designs and specifications to meet local conditions is recognized, but the advisability of attempting to adopt these modifications as "standards" is questioned. It is also appreciated that brick has its limitations and its place in the paving of streets and roads.

A study of existing brick pavements and the effects upon them of traffic and of soil and climatic conditions shows a process of elimination in types of brick and brick-pavement design. The evolution has been gradual, because it has required time to demonstrate the relative merits of different types and designs.

When paving brick was introduced in 1870, the "standard" was a plain wire-cut brick, and the design provided for a sand cushion, a sand filler, and a foundation of No. 2 brick laid flat on rolled stone, or gravel. Pavements of this type have been in service for thirty years. They have proved the wearing qualities of No. 1 brick and have been a good investment for taxpayers, but they have somewhat handicapped the industry, because the change in motive power of vehicles has created a demand for pavements to carry an increased weight and volume of traffic, and for smoother pavements, and because the average taxpayer does not realize that these pavements have given full service and have been used thru more than the normal life of a brick pavement. Many of these pavements are rough and unsanitary, because the unprotected edges of the brick have been cobbled and they are uneven because of frequent openings in the surface and the movement of the sand cushion under the vibration of heavy traffic. Thirty years is more than the life of any pavement under normal traffic, unless it be granite block, but many brick pavements have been in use for that length of time.

In an attempt to overcome the disadvantages of sand filler, engineers began to use tar, pitch-mastic or cement-grout filler, which resulted in the introduction and adoption of repressed brick with buttons, bars or raised letters on the side to admit the filler to the full depth of the brick. The merits of this style of brick were recognized and it was adopted as a "standard."

Tar did not prove an entirely satisfactory filler, because of the difficulty of maintaining it in the joints and flush with the top, and the pitch-mastic was introduced to overcome this objection. The cement-sand filler, because of its structural advantages and the apparent ease of mixing and applying it, together with its low cost, brought about its very general use. Imperfect workmanship in securing the proper consistency, in methods of application, in the preparation of the bedding course and in securing maximum penetration, led to defects in grout-filled brick pavements. In addition, temperature stresses not uniformly distributed because of poor grouting, caused failures, with the result that asphalt was advocated to eliminate the hazard in the use of grout fillers.

The rounded edges of repressed brick made it difficult to keep the grout filler flush with the top of the brick, and repressing sometimes caused laminations that affected the internal structure and durability of the brick. In addition, in repressing, the buttons or projections were frequently deformed so that they did not serve their purpose. These factors led to the perfecting of the wire-cut lug brick which was introduced in 1910 and has been adopted as one of the "standard" types by many city engineers and organizations. The use of this type will assist in eliminating some of the construction hazards, but no type of brick or other material used for surfacing is entirely free from structural defects, due to the "human equation," nor will entirely resist the natural forces which tend to destroy pavements.

Under existing conditions in the paving brick industry, the engineer is not in a position to recognize one "standard" style of brick, nor should he consider but one design for brick pavements. It is possible, however, to adopt types of brick that have proved their merit in service, and to design pavements with reference to local conditions and requirements.

A lugless paving brick has been advocated on the theory of commercial and economic advantage to the paving-brick industry, without due regard to past experience or the best engineering practice in brick-pavement construction. This type, we are advised, will provide for spacing by means of kiln marks on the brick or roller action in preparing the surface. The word "uniformity" is probably the most important slogan in the construction of pavements, regardless of the kind of material used, and it is believed that to adopt as "standard" a type of brick that does not insure definite and positive joints is a backward step in brick making and pavement design. The reasons for this belief are:

(a) Experience and experiments have demonstrated the necessity of definite joint spacing to permit the filler to penetrate to the full depth of the brick.

(b) If a bulge on the end of a lugless brick is desirable to provide for spacing, it should be self evident that definite joints should be required on the side of the brick.

(c) Manufacturers have advocated the use of bricks with lugs, buttons or bars to provide positive joints. Abandoning this policy at a time when engineers are not in a position to experiment seems to be a serious mistake, but, fortunately, only a limited number of plants are making lugless bricks.

Engineers and engineering organizations are interested only for the purpose of obtaining specifications that will produce dependable brick pavements, but unless their attention is specifically directed to certain features of paving brick, they are not likely to be discussed, nor is it likely that they will adopt as "standard," specifications that will benefit all parties interested.

At the Grand Rapids meeting of the American Society for Municipal Improvements in 1911, there were adopted specifications for a standard-size paving block 3½ in. wide, 4 in. deep and 8½ in.

long, with lugs not over ¼ in. high on one side. The same specifications were adopted by the Association for Standardizing Paving Specifications in 1912. Engineers generally call for this size in their specification; and any material change in the "standard" size would cause inconvenience in repair and maintenance and undo a great deal of work that has required years for its accomplishment.

Western paving-brick manufacturers have established a market for a brick 3 in. deep, with bars on the side to provide spacing, known as vertical fiber brick. The 3-in. size has never been standardized by the industry or a national organization, and there is no question as to the desirability of adopting definite standard sizes and tests for both vertical fiber and wire-cut brick. Repressed bricks are not manufactured in the 3-in. size.

Refined asphalt has been used extensively and with various results as a filler for vertical fiber brick pavements. The quality of the material, its melting point, and the skill used in heating and applying, are important factors in its success or failure. The practice of applying enough asphalt to construct a bituminous mat over a brick pavement does not appear to be good practice. The asphalt will not adhere at all seasons and will peel off unless held in place by a mechanical bond due to the rough texture of the brick or to the joint spaces. Applying asphalt by the squeegee method often bridges over joints. Pouring into the joints insures better penetration and the saving in the amount used will more than pay the cost of the additional labor.

The filler provides for expansion stresses and helps make a smooth surface, providing the joints are filled flush with the surface. On pavements carrying a large amount of horse and steel-tired traffic, the filler will be cut out of the joints at the top within a few years and will require renewal. This maintenance feature is generally overlooked.

The engineer is frequently in doubt whether to use a bituminous or cement-grout filler. Each type has its place and the engineer should carefully analyze local conditions. As a general proposition, bituminous filler is best adapted to a wearing surface laid upon a new macadam or gravel foundation, while the cement-grout filler is adapted to use where the sub-grade is stable and where there is a rigid foundation.

Failures of foundations under all types of surfacing have raised the question of whether the failures were due to motor-truck loads and wheel impact, or to poor design or construction, or to inadequate drainage and low bearing value of the sub-grade. Engineering organizations are making special studies of the bearing power of soils that should prove of great value in foundation design. For a national engineering organization, however, to consider a reduction in the thickness of concrete foundation to less than 6 in.

under existing conditions will not meet with the approval of engineers. On the other hand, engineers should be sufficiently informed to modify "standard" foundation designs to meet local conditions. It is also reasonable to suggest variations in the depth of concrete foundation depending upon whether cement grout or bituminous filler is used, but this should be treated as a local matter.

The bed or so-called cushion for brick pavement may be of sand, cement-sand, slag or stone screenings, and is usually 1 in. deep. Sand has been used with more or less success, depending upon the care taken in preparing the bed and the quality and grading of the sand. Fine sand with a small amount of loam or silt has not given entirely satisfactory results, because of its tendency, when moist, to work into the joints and prevent the filler from penetrating to the full depth, and its tendency, when dry, to subside, leaving partly filled joints. Defects in brick pavements due to temperature stresses may be attributed to the sand bed or to poor grouting. A bed of coarse sand drains much better than one of fine sand, and, when properly rolled and struck off, furnishes a satisfactory bed of uniform density.

Many engineers recommend a cement-sand bed, generally consisting of 1 part of cement to 4 parts of sand, spread dry over the artificial foundation. The mixture may work into the joints, but will remain there. Furthermore, it prevents shifting of the bed under the vibration of vehicle traffic, and so furnishes a uniform bearing for the brick. "Standard" specifications for cement-sand bed would appear to be worthy of favorable consideration and adoption.

Engineers differ as to the use of expansion joints at fixed intervals in a brick pavement with a cement-grout filler. The advisability of attempting to control temperature stresses with transverse joints is questioned. A study of pavements with expansion joints indicates weakness in the structure at or near the joints. No. 1 paving brick will not crush under expansion stresses, if the grout extends to the full depth of the brick. Expansion stresses may be divided into a number of units by paved street intersections which confine them within the limits of one city block. Where they are not so confined, they are cumulative over the entire length of the pavement and there is likely to be a rupture at the point of the least resistance, ordinarily a sudden change in the grade or where there is some structural defect. A large percentage of blow-ups in grouted brick pavements are due to defective joints at the end of a day's run or at a break in the grade.

This theory as to the elimination of expansion joints justifies the opinion that each paved street intersection may be considered a "compression header." If an intersection is not improved, a concrete header should be placed at the beginning and end of the work to confine the stresses within the limits of one block. A complete separation of the pavement proper is necessary at alley entrances and driveways. It would be desirable also to construct manhole frames and castings so that they could move with the paving. Longitudinal expansion joints should be placed at each curb line to permit free movement of the slab and take care of the transverse expansion.

In directing attention to certain features of paving brick and brick pavements, it seems consistent to add that no one material or design will meet every local requirement, nor will pavements be free from inherent defects due to materials or to methods of manufacturing. The engineer's problem is to adopt materials, designs and specifications that will meet local requirements, and in this process, experience is the best teacher.

BRICKS VS. BLOCKS

By S. Cameron Corson, Boro Engineer, Norristown, Pa.

I wish to be placed on record as being against blocks, as they are manufactured to-day, but for the old standard repressed paving bricks: I am of the opinion from my personal experience here that the bricks are preferable to the blocks. They are better burned and are thereby better vitrified. There are not the laminations in them that are shown in broken blocks. Our brick pavements have been laid since 1897 and altho they are beginning to show signs of wear, they are in excellent condition. They were laid without expansion joints with cement-grout filler, one to one cement and bar sand. Care was always taken not to sweep the deposit in the box out onto the pavement, but it was allowed to remain for the next batch.

Pavements were laid on 4½-inch concrete base with 2-inch sand cushion drawn to proper contour by hand, but not rolled. The only rolling was done by a 3-ton horse roller. There is one place (described in my paper in 1919) where longitudinal and a few transverse cracks appeared about 1901 or 1902, but there have been no disintegrations or worn-out bricks in consequence, the traffic being down-grade over this point. The pavements laid with a hot asphalt filler instead of cement grout are standing up fairly well, altho all or nearly all of the filler has been forced to the surface, then broken off and washed or swept away. There is little or no traffic on these streets on which this asphalt filler has been used. On several occasions I have seen evidences of street sweepings in the joints instead of the original asphalt filler.

Later more bricks were laid of another kind and a different location. These bricks are nearly all in a good condition. They were laid on a 4½-inch concrete base with 1½-inch sand cushion, an expansion joint running along the curbs and along the rail. These bricks seem to stand up splendidly with considerable traffic of the heavy auto type. Then we started to use the blocks, and in many instances our pavements are being destroyed by the longitudinal and transverse cracks, expansion joints having little or no effect. Blocks in the middle of the pavement have disintegrated and gone to pieces allowing the heavy traffic to crush the adjoining blocks, soon causing a dangerous hole. There seems to have been no reason for these blocks to have been crushed and gone to pieces other than is stated in my 1919 paper. They were not as thoroly burned as are bricks. I have personally examined many such places before our last convention and since then, and I have found in each instance that these blocks absorb considerable water, that they are not thoroly burned, that they are or have not been vitrified to the extent that bricks can be and are burned, and I attribute these broken bricks to this fact.

Only two years ago we laid a block of these same wire-cut lug blocks and to-day there are cracks and isolated broken blocks. Expansion joints were used of the plug-tobacco type and I have my doubts as to the efficiency of that material.

This year we have just finished a street about 700 feet by the Lehigh Valley Transit Co., 36 feet wide, in which I have specified 1½-inch expansion joints on each side of the street, as the ¾-inch joints used two years ago have been forced nearly the entire width of the material (4 inches) out of the joint, which in some instances has flattened out to nearly double its original width. This is particularly true at the 10-ft.-radius circular corners, my contention being that one must take into consideration the extreme diagonal distance on the intersection between circular corners, 36 feet (or any distance) between curb lines, which would give a diagonal distance of 58 feet to the face of each 10-foot-radius circular corner. This being true, what should be the necessary width or thickness of the expansion joint? Some use 1 inch for streets 24 feet wide. Some claim 1-inch joint for each side of the street, making 2 inches. What is the correct thickness?

The agent for one filler gave me a rule to apply to this question, but when I gave him this problem of the diagonal cross-line 58 feet long, his rule gave a joint of 3½ inches for each crack or 7 inches in all, whether it be a poured or placed joint. The vertical fiber bricks may be what we need here to overcome our difficulty, but I have never seen any in use in this vicinity, nor have I ever heard of their being used near here. My humble opinion is that a steel tram should be incorporated on all of the main thorofare roads, especially on those roads that are the main arteries between large cities. These trams outside of the cities should be laid similar to a double track to points where the traffic will warrant one track, these trams to be not less than 18 inches wide with a ¾-inch flange turned up to hold adjoining pavements, spaced 5 inches c. to c. and T-shape, held apart and in place by cross-rods buried in the concrete base, the concrete to be so placed that the tram rail will rest upon the concrete base. These would give ample room for the largest truck tires and by their use save the adjoining pavements of whatever materials they may be constructed. The cost of this construction at this time would be possibly prohibitive, but its use would be a godsend to our public roads.

EXPERIMENTAL PAVEMENTS IN THE BORO OF QUEENS

By Fred H. Shepheard, Assistant Engineer, and E. E. Butterfield, in Charge of Tests, Long Island City, N. Y.

NOTE:—Experimental work was conducted with the co-operation of the Office of Public Roads and Rural Engineering on Hillside avenue, Jamaica, Boro of Queens, in 1911, and published in Circular No. 98 of the Office of Public Roads. The work here reported does not include this earlier experimental work but relates solely to work done in the Office of the Boro President since July, 1918.

Experimental work in highway construction is necessary for the accomplishment of any decided progress or improvement. While the United States Office of Public Roads and Rural Engineering has been especially active in prosecuting necessary experiments, the conditions under which their experiments are carried out and the usual limitation of their field work to country roads, do not always permit of an extension or a generalization of the results to the conditions of metropolitan traffic.

The general purposes of experimental work are to obtain service records as to:

First: Materials.
Second: Methods and types of construction.
Third: So-called standard pavements under different conditions of traffic.

In the selection of materials and methods it is desirable to confine oneself to conditions which offer either some theoretical or economic advantage over prevailing conditions. The experiments which are here described commenced with the preparation of new specifications for bituminous materials for macadam construction, for top dressing on old bituminous macadam, and for dust laying. The preparation of the new specifications was necessitated by the variable quality of bituminous materials received in 1918. The success which attended the adoption of the new specifications with respect to price, convenience of application, and stability and permanence of construction led to further experiments with non-bituminous and miscellaneous materials.

The conditions in the Boro of Queens presented many advantages for the planning and carrying out of such experimental work. In the first place practically all conditions of traffic can be found in different parts of the Boro, varying from metropolitan heavy trucking traffic to the light vehicular traffic of the less frequented country roads. In the second place, in the Office of the Boro President the general highway work is divided into a Bureau of Maintenance and a Bureau of Highway Construction proper. Our experiments were all conducted in the Bureau of Maintenance and were confined in each instance in the beginning to rather small repair stretches.

This presents the decided advantage of acquiring valuable information as to service, cost, and specification details without incurring expenditures of any considerable size. This information then becomes available for the preparation of specifications for contract work in the Bureau of Highway Construction, if it should appear advisable to extend the experiments on a larger scale.

It would not be reasonable or desirable to advertise for construction contracts covering a considerable yardage of new materials or new types of construction without having previously acquired accurate and detailed information as to costs, durability, and specification details on the properties of materials and the methods of construction. This information can be and has been obtained in the Maintenance Department on stretches varying in size from small patches up to several blocks of curb-to-curb work.

BITUMINOUS MATERIALS

In connection with the purchase of bituminous materials the general change was made in the direction of embodying more independent variables in the specification requirements covering the properties of consistency, flow and volatility of the materials and their residues. The first change was made in our specifications for bituminous macadam binder, to be used in bituminous macadam construction by the penetration method. Up to and including 1918 a coal-tar product had been used exclusively for this purpose. Variations in different deliveries of the same material in 1918, as well as the appearance of a higher percentage naphthalene in the distillate led us to place asphaltic macadam binder in competition with the coal-tar product. The present specifications for bituminous materials are essentially the same as the specifications given in Bulletin No. 691 of the U. S. Department of Agriculture, "Typical Specifications for Bituminous Road Materials." The form of our specifications is identical with those of the Office of Public Roads but the limits have been changed to embrace all of the materials in a given class available in the New York market. Materials furnished under this specification have had the following properties:

	Minimum	Maximum
Specific gravity at 25°/25°C	0.97	1.056
Flash point	178	210
Melting point	44	51
Penetration at 25°C., 100 g., 5 sec	85	128
Loss at 163°C., 5 hrs.	0.2	0.8
a. Penetration of residue at 25°C. 100 g., 5 sec	63	90
Total Bitumen (soluble in CS_2)	99.5	99.9

The results have been entirely satisfactory as to costs, convenience of application and permanence of construction.

The next change was made in the asphaltic material for top dressing or carpeting medium on old bituminous macadam. For this purpose a No. 6 asphaltic oil was previously used. The deliveries of material in 1918 were not only variable in quality but the material showed comparatively little binding power and the surface of the road was in some cases even mushy. The following specification was then prepared and the materials delivered under this specification have been considerably stiffer, more of the nature of a light macadam binder, as is shown by the following analytical results on the materials delivered:

1. *Waldo Avenue at Bradish Avenue, Bayside, Boro of Queens, Showing Dirt Road Surfaced with Ash Fill and Cold Asphaltic Road-oil*

The road oil shall be homogeneous, free from water, and shall not foam when heated to 120°C. (248°F.) It shall meet the following requirements:

	Specification Requirements	Deliveries	
		Minimum	Maximum
1. Specific gravity 25°/25°C. (77°/77°F.)	Not less than 0.980	1.00	1.03
2. Flash point	Not less than 80°C (176°F.)	85	180
3. Specific viscosity at 100°C. (212°F.)	Not more than 60	32	52
4. Float test at 32°C. (89.6°F.)	Not less than 60 secs.	310	720
5. Loss at 163°C. (325°F.), 5 hours	Not more than 15%	1.9	2.4
a. Float test of residue at 50°C. (122°F.)	Not less than 110 sec.	191	255
6. Total bitumen (soluble in CS_2)	Not less than 99.5%	99.1	99.9
7. Per cent of total bitumen insoluble in 86°B. naphtha	Not less than 6%	20	25

The results of this material have been very satisfactory, particularly in the uniformity of application and the stability of the resulting surface.

When this material was delivered it was suggested from a number of sources that the materials admitted under the specification would be too heavy for the purpose of carpeting, and that patches of sticky semi-solid bitumen would remain on the road and cause nuisance to pedestrians in tracking sticky materials from the road to sidewalks and even into the homes. This did not prove to be the case.

The next change was made in specifications for light road-oil chiefly for use as a dust-layer on dirt roads. For this purpose a No. 4 asphaltic oil was formerly used whereas the present specification calls for the following material:

2. *Doncaster Boulevard, Hillcrest Section, Jamaica, Boro of Queens, Showing Old Macadam Surfaced with Grits and Asphaltic Road-oil Applied Hot*

The road-oil shall be homogeneous and free from water.

It shall meet the following requirements:

1. Specific gravity at 25°/25°C (77°/77°F.), 0.930 to 0.975.
2. Specific viscosity at 50°C., not more than 30.
3. Loss at 163°C. (325°F.), 5 hrs., not more than 30%.
   a. Float test of residue at 50°C., not less than 50 sec.
4. Total bitumen (soluble in CS_2), not less than 99.5%.
5. Per cent of total bitumen insoluble in 86° B. Naphtha, not less than 6.0%.

While the material delivered under this specification does not appear to be heavier than a No. 4 road oil, its behavior on the road has been characterized by its tendency to form a stable bituminous surface on dirt roads. The oil dried within a reasonable period and the residual bitumen became matted under traffic with the dirt of the road forming a solid carpeting mass. By repeated applications a bituminous surface varying from a quarter to half an inch has thus been built up upon our dirt roads. Advantage of this fact has been taken for an innovation in the practice of treating our dirt roads this year (1920). Steam ashes have been purchased and used to fill in holes and irregularities in the surface of the roads and to this layer of steam ashes cold road-oil has been applied. In this manner it is proposed to form a more or less permanent bituminous carpet on our principal dirt roads.

In the case of all three bituminous materials there was wide competition in bidding, more than three and in some cases seven bids having been received on the materials. In 1919 the estimated saving, as compared with materials used in the past, was between $20,000 and $30,000.

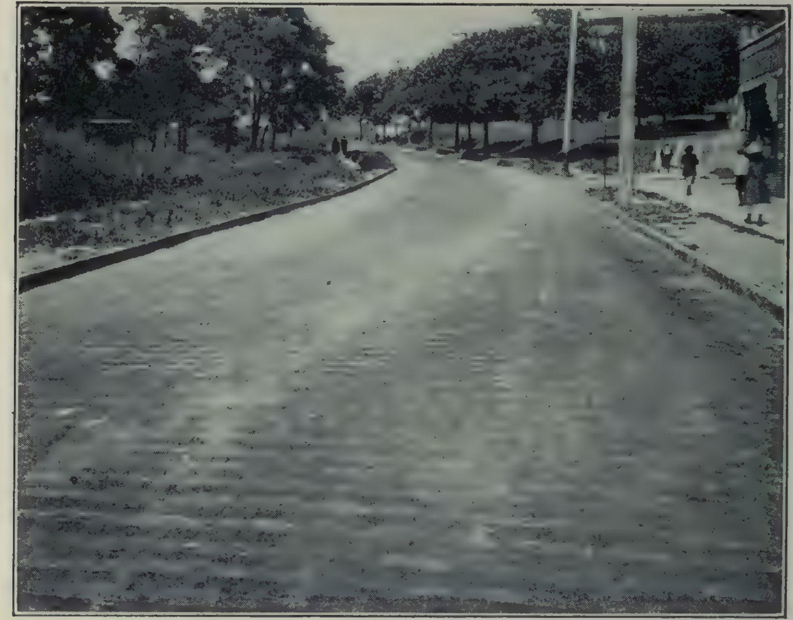
The changes in specifications for bituminous materials can hardly be regarded as experimental paving but are mentioned here as the starting point of our experimental work and because they actually led to change in the method of treatment of dirt roads.

WOOD BLOCK PAVEMENT

Difficulty experienced in 1918 in obtaining creosoted pine blocks to meet the specifications which were then effective led to an investigation of the physical properties of American hardwoods with the object in view of determining their possible application in wood block pavements. The results of this investigation have been published in Engineering News Record, Vol. 85, p. 656, Sept. 30, 1920.

Commencing in 1919 and continuing this year, untreated white-oak blocks have been used for repairs to existing wood-block pavements. The principal reasons for the change were deduced from the results of physical tests. Oak is tougher and stronger than creosoted pine and is consequently much less subject to shear or fracture from expansion or from traffic. Since the oak blocks are untreated, reasonable measures must be taken to protect the blocks from the ingress of water. The practice in Europe has been to dip the blocks in tar just before laying; this practice would undoubtedly prove too tedious and too costly for American conditions. As an alternative it is suggested that the blocks be laid on a coat of stiff bituminous material, such as a 50 to 70 penetration asphaltic cement, applied directly to the foundation and then covered after laying, rolling, and joint filling, with a thin coat of bituminous material upon which fine sand is then spread. If the foundation is too rough to permit attaining a sufficiently even surface by direct application of bitumen, it is suggested that a bed of bituminous mastic carrying about 8% of bitumen be applied to the foundation and the blocks laid in the bituminous mastic bed.

If the work embraces curb-to-curb work over 100 feet in length attention should be paid to lateral and transverse expansion joints. In the specifications for materials no mention is made of checking in the blocks. The reason for this is that the best grades of oak will check on drying out and the presence or absence of checks is simply an index of moisture content. The presence of checks has not been found to be of any disadvantage or detrimental to the pavement in any way.



3. *Flushing Avenue at Hillside Avenue, Boro of Queens, Showing Key-Block Pavement of Alternate Rows of Granite Block and Oak Key-Block*

The specifications for the experimental work provide for bringing the old concrete foundation to the new grade and for a mastic cushion, laid hot, and ¼ to ½ of an inch in depth. Alternative specifications for the asphaltic cement are given.

The hard-wood blocks were required to be white oak or chestnut oak, sound, well manufactured, square butted, square edged, free from unsound, loose, or hollow knots, knot holes, worm holes, wane, or other defects that would be detrimental to the blocks, the direction of the grain not to vary more than 10% from the perpendicular; the dimensions to be from 7 inches to 9 inches in length, 3½ inches in depth, and 3 inches in width, variations in width or depth not to exceed ⅛ inch. The shearing strength parallel to the grain and radial was fixed at not less than 1000 pounds per square inch; the toughness, tested with the Page impact machine on cylindrical cores 2.5 cm. x 2.5 cm., at not less than 25 in the direction of the grain.

Two-inch lateral expansion joints were provided at each curb, and at intervals of each 50 feet transverse expansion joints from curb to curb 2 inches wide, all with bituminous joint filler.

All joints were filled with asphaltic cement of 50 to 60 penetration, at a temperature from 325°F. to 400°F., and the pavement covered with fine, clean, and dry sand and protected from vehicular traffic for at least two days.

KEY BLOCK PAVEMENT

This is a combination of a wood-block and a granite-block pavement, presenting alternating courses of wood and of granite block laid at right angles to the direction of traffic. The unique feature is an oak block of wedge or key-stone shape, 4″ x 5″ on the wearing surface, tapering at the sides to a width which is ½″ to 1″ less at the bottom than that of the wearing surface; the depth is about 4″. Courses of granite blocks are first laid with a space of 3½ to 3¾ of an inch between the courses. The transverse spaces are then partly filled with sand and the keys are then firmly rammed in between the rows of granite block. The result is a series of alternating courses of granite with oak blocks tightly wedged between them. This type of construction has been used extensively for the past seven years in the franchise area of the New York Railways Company, particularly at street intersections which are subjected to unusually heavy traffic. It is essentially an economical method of repairing or repaving a worn granite-block pavement to meet conditions of excessively heavy traffic. Theoretically the heavier the traffic the better the pavement should stand up. Because of the overhanging edge of the oak key the edges of the granite blocks are protected from abrasion and chipping. As the oak blocks project slightly above the level of the granite the wood consequently bears the brunt of the traffic and the harder the oak blocks are pounded by traffic the tighter they should become wedged in, thereby increasing the stability of the whole pavement. To test the correctness of the theory a street subjected to heavy trucking traffic was selected on which there was a badly worn Belgian-block pavement on an old macadam base. The grade is 7%. The street represents a short cut between Flushing and Jamaica and frequent complaints had been made on the roughness and slipperiness of the old Belgian-block pavement. There were also complaints from the noise of the trucks rattling over the old Belgian-block pavement. It was desirable to alleviate this condition if possible on account of the Normal School which is situated on the street. The street is subjected to considerable wash during rain and thaws as it provides surface drainage for considerable adjacent territory. In

June, 1919, the key blocks were laid with departmental labor to repair several blocks of this street, Flushing avenue, from Hillside avenue to Maxwell avenue, Jamaica. The blocks were laid on a sand cushion directly on the old macadam base. There has been a material reduction in slipperiness and noise and the general results have been entirely satisfactory to date.

The special features of the specifications provided for thoroly compacting the dirt or sand foundation, bringing to the required crown and rolling with a ten-ton tandem roller; a bed of clean, coarse, dry sand ¾ inch to 2 inches deep.

Upon the sand cushion six courses of granite block culled as to regularity in width and depth were laid with spaces between rows, which were partly filled with sand and key blocks then placed in the spaces with the concavities of the blocks facing opposite rows of granite blocks, and with the flat ends of keys in as close apposition as possible; the key blocks selected and placed so as to require hard ramming to force the blocks to a level from 1/16 to 3/16 of an inch above the surface of the granite blocks. The joints were filled with a bituminous joint filler and the pavement evenly covered with a flush coat of the same bituminous joint filler and clean fine sand evenly spread thereon.

The woods were white-oak or chestnut-oak free from unsound, loose, or hollow knots, worm holes, wane or other defects that would be detrimental to the blocks, cut to have a flat widened head and a tapering body, the head overhanging the body.

BITUMINOUS MACADAM

The results of recent work on cement-concrete aggregates show in general that the strength of concrete is independent of the mineralogical nature of the aggregates. The strength of the stone or gravel composing mineral aggregates is so far in excess of the strength of cement concrete that there is no particular advantage in selecting material for an aggregate which would show a compressive strength of 20,000 pounds, when the compressive strength of the resulting concrete, as usually mixed, will not exceed 2,000 pounds per square inch. In the same manner the strength of a bituminous mixture is not determined by the strength of the stone but rather by the density of the mixture and the properties of the bituminous binder. Theoretically a softer stone in a well graded aggregate, low in voids, combined with a fairly stiff macadam binder should give just as good or better results than a very hard stone in combination with a softer binder. In any case the aggregate should possess a reasonable degree of toughness and resistance to abrasion in case particles should become exposed to the direct action of traffic. Instances have been noted where the use of extremely hard stone has apparently been accompanied by the disadvantage of inequality in the wear of the matrix in which the stone is imbedded and the wear of the stone itself, leaving the stone projecting irregularly along the course of the roadway, both in cement-concrete and bituminous construction.

In the prevailing type of macadam construction in the Boro of Queens trap rock has been used exclusively. In order to test the assumptions previously outlined an aggregate was selected which consisted essentially of crushed field stone, but contained also as much as 50% of rounded material which had slipped thru the rim of the crusher. The aggregate presented a continuous grading and extremely low voids. The material in a graded mixture of 1½-in., ¾-in. and ⅜-in. sizes gave a compressive strength of 2,800 pounds to 3,000 pounds in a 1:2:4 cement-concrete mix with a water ratio of 0.8. The toughness varied between 8 and 14 and the French coefficient of wear between 10 and 14.

4. *Harriman Avenue at Shelton Avenue, Looking Toward Hillside Avenue, Jamaica, Boro of Queens, Showing Asphaltic Concrete Street. Topeka Mix, using Graded Gravel Aggregate*

The old macadam roadway was scarified, reshaped, and covered 1½-in. aggregate sufficient to make the total depth of 1½-in. material 6 inches after rolling. The surface was sprinkled with sand and then rolled. The bituminous macadam binder previously described was then applied at the rate of 1½ to 1¾ gallons per square yard. The surface was then covered with a mixture of material of the same nature corresponding in general grading requirements to broken-stone screenings, one cubic yard of material covering from 24 to 32 square yards of roadway. Owing to the compactness of the 1½-in. graded aggregate after rolling, an intermediate course of ¾-in. material was not used. No seal coat was applied. The bitumen is gradually drawn to the surface by the heat of the sun and capillarity. The results have been remarkably satisfactory, fully equalling if not surpassing the results obtained with aggregates consisting solely of sharp angular fragments of hard trap rock. On Van Wyck avenue, Jamaica, where there is an absence of shade, the bitumen has come to the top within two months and the appearance of the pavement resembles asphaltic concrete.

BITUMINOUS CONCRETE

The same general considerations as to the hardness of the stone, the density of the resulting mixture, and the properties of the binder apply more forcefully to asphaltic concrete mixtures than they do to bituminous macadam construction by the penetration method. Bituminous concrete of the Topeka specification type was laid with finer material from the graded gravel aggregate and 50 to 60 penetration asphaltic cement. The results have been entirely satisfactory from the handling of the material in the asphalt plant to the laying of the finished pavement. The low voids enable one to make and lay an extremely dense mixture with a minimum of bitumen. The appearance and finish is equal to the best street asphalt pavements. The coarse aggregate possesses the following properties as to grading:

	Per cent
Retained on 2-mesh	0.0
Passing 2-mesh, retained on 4-mesh	17.3
Passing 4-mesh, retained on 10-mesh	52.5
Passing 10-mesh, retained on 40-mesh	26.3
Passing 40-mesh, retained on 80-mesh	2.8
Passing 80-mesh, retained on 200-mesh	0.6
Passing 200-mesh	0.5

Voids = 9.0%

THE WATER SUPPLY OF ST. LOUIS

By Francis T. Cutts, Assistant Water Commissioner

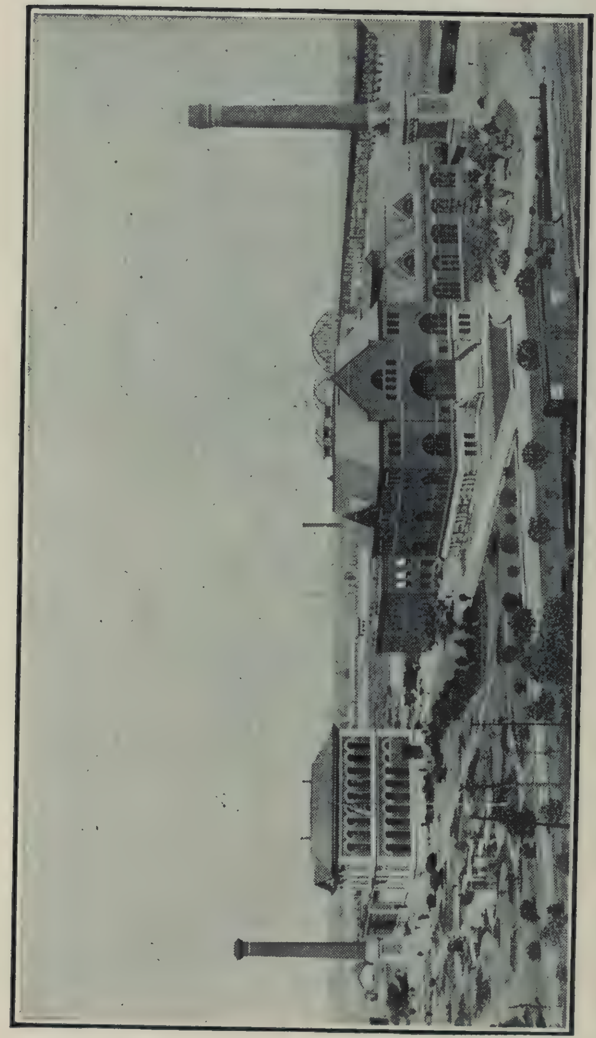
The city of St. Louis acquired control of the water-works system in 1835 and ever since that time the entire supply has been furnished by a municipally owned plant. The source of supply is now, and has always been, the Mississippi River, which furnishes a water in which bacteria flourish, that is high in turbidity, and at times high in color, and which has a fluctuation of more than thirty feet between extreme high-and low-water stages.

The first pumping station was located just outside the city limits at the foot of Smith street and the water was pumped from the river to a reservoir located at Collins and Dickson streets. As the population of the city increased and greater demands were made on the water system new and larger pumps were installed and new and larger reservoirs were built with a corresponding growth in the distribution system.

The fifth and last reservoir supplied from the Smith street pumping station was located at Gamble and Dayton streets, and was put in service in 1868, prior to the extension of the city limits in 1876. At that time it became evident to those in charge of the works that in order to provide an adequate future supply and to lessen the danger of contamination from sewage, it would be necessary to abandon the Smith street intake and pumping station and to build new works at some location sufficiently removed to eliminate danger of a polluted water supply.

After much discussion, a site between Ferry street and Grand avenue, and about three miles north of the Eads bridge was selected and the construction work begun. The plan provided for an intake, a low-service pumping station, four settling basins, each 227 feet by 600 feet, a high-service pumping station and a storage reservoir at Compton Hill about five miles away with necessary stand-pipes, pump-mains and distributing pipes. These works, known as the Bissell's Point station, were partially completed and put in operation in 1871, and the Smith street pumping station was finally abandoned. The capacity of this station was constantly increased as the increase in consumption demanded until finally it became apparent that further increase in low-service pumping capacity would be undesirable on account of the rapidly increasing amount of sewage that was emptied into the Mississippi thru Harlem Creek, just above the intake at Bissell's Point.

Finally in 1887, legislation was enacted, providing funds for the removal of the intake and low-service pumping station to a point



1. *General View of Pumping Station at Bissell's Point*

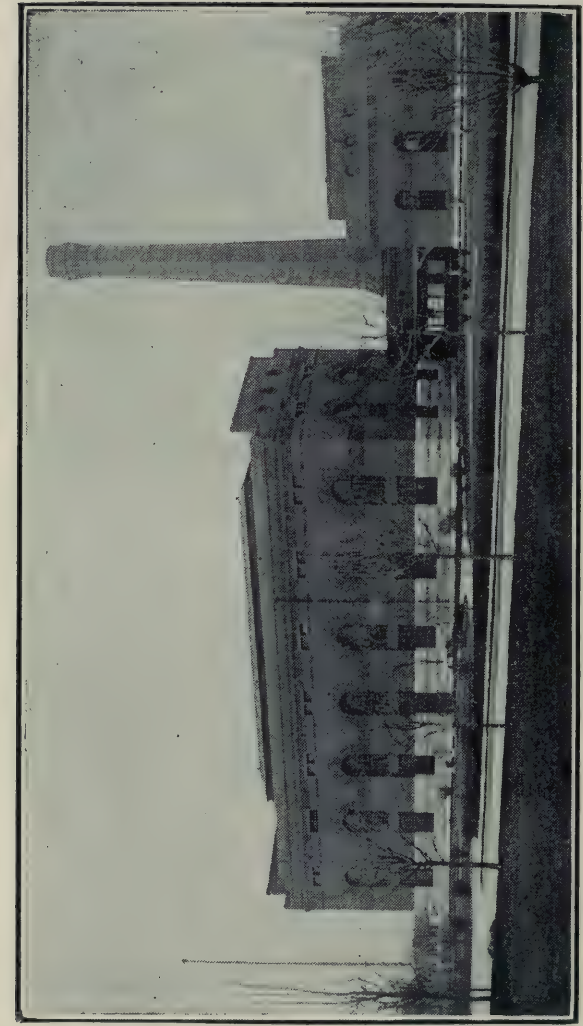
known as the Chain of Rocks, 10½ miles above the Eads bridge and 5½ miles below the mouth of the Missouri river and near the northern extremity of the city limits as established in 1876. Before this new low-service station was ready for service, it was found that the newer sections of the city could not be supplied with water at adequate pressure from the one high-service pumping station at Bissell's Point, and in 1893 funds were provided for the building of a second high-service pumping station at Baden about 6½ miles above the Eads bridge.

The new works at the Chain of Rocks were first put in service April 19, 1895, and consisted of an intake tower and tunnel, a low-service or river pumping station, and six settling basins, each 400 feet by 670 feet with a masonry conduit extending to the high-service station at Bissell's Point, 7½ miles below.

The water-supply system during the following three years consisted then of the low-service pumping station at the Chain of Rocks and the one high-service pumping station at Bissell's Point with a good distribution system, the pump mains being 36-inch cast-iron pipe. In 1898 the second high-service pumping station was put in service at Baden. The pressure at this station was carried at 125 pounds, sufficient to serve the high levels of the city, while the pressure at the Bissell's Point station was carried at 83 pounds, sufficient to serve the older portions of the city.

The capacity of the works at this time was 80,000,000 gallons per day. The scheme of operation was briefly as follows: Water was drawn thru the gates of a single intake tower located 1600 feet from the Missouri shore at the Chain of Rocks, flowed thru a 7-foot brick-lined tunnel (driven thru rock) extending from the intake tower to a wet well 23 feet by 152 feet located about 600 feet inshore and close to the low-service pumps. From this well, the water was pumped to a delivery well (lift varying from 35 to 65 feet and averaging 48 feet) and flowed from this well thru a 9-foot conduit to the sedimentation basins, of which there were six, each 670 feet by 400 feet. These basins were operated on the fill-and-draw plan which allowed, during normal consumption periods, a simple settlement of 60 hours. Leaving the basins the water was drawn thru a drawing conduit and then flowed by gravity thru a single brick conduit to the high-service pumping stations, one at Baden and one at Bissell's Point, where it was sent thru the distribution mains to the consumers and to the storage reservoir at Compton Hill.

Up to this time, 1898, no attempt had been made to clarify the water except by the simple settlement in the basins at the Chain of Rocks, and the water delivered to the consumer was quite cloudy and carried a certain amount of finely divided matter in suspension. It was decidedly better, however, than that furnished from either the Smith street or the Bissell's Point intake and very different from that which Mark Twain described as "holding an acre of land in solution in each tumbler full and being good for steam-



2. *Pumping Station at Baden*

boating and good to drink, but worthless for all other purposes except baptizing." Public sentiment began to demand clear water and as the consumption increased and the time for settlement in the basins at the Chain necessarily became lessened and a water more and more turbid had to be sent thru the mains, the citizens lost confidence in the efficiency of the settling basins at the low-service pumping station and there was some talk of abandoning the present works and taking the supply from some other source than the Mississippi.

It was during the period of agitation that extensive experiments were conducted with the view of determining a practicable method of clarifying and purifying the supply. Most of the experimenting was done on a small scale and the plan finally adopted was not given a trial on a large quantity of water until March 21, 1904, just prior to the opening of the Louisiana Purchase Exposition. At that time there was put into successful operation a scheme of coagulation and sedimentation with sulphate of iron and lime as the agents. This scheme necessitated some changes in the settling basins as well as a change in their method of operation. A solution of sulphate of iron was introduced into the water as it flowed from the river to the wet well. The lime (as milk of lime) was introduced into the water in the delivery well. The water thus charged with coagulants in proper proportion entered Basin No. 1 thru a receiving and stilling chamber, and flowed successively over weirs thru Basins Nos. 2, 3, 4, 5 and 6 and was drawn from Basin No. 6 into a delivery conduit and on thru the conduit to the Baden and Bissell's Point high-service pumping stations. The results obtained from the experimental plant were so very satisfactory that steps were immediately taken to work out a design for a permanent plant, equipped with automatic machinery for handling, mixing and applying the chemicals along lines which experience showed to be most effective. This plan called for the building of two additional basins at the Chain of Rocks. Those basins, known as No. 7 and No. 8, each 400 feet by 800 feet were put in service in 1908 and a new coagulant house in 1909. A little later Basin No. 8 was divided into two basins (No. 8 and No. 9) each 400 feet by 400 feet and conduits so arranged as to permit of the introduction of the coagulated water into Basin No. 9 in a manner similar to that used in Basin No. 1.

At this time the daily working capacity of the Works was about 120,000,000 gallons and the consumption had increased to such an extent as to raise the peak pumping loads well above the safe working capacities. This applied particularly to the clarification capacity, which was placed at only 100,000,000 gallons per day. When periods of extreme turbidities in the raw water were simultaneous with periods of maximum consumption, the water delivered to the consumer was of necessity only partially clarified. The situation with reference to the need of increasing the capacity of the works and of eventually again building new works to take the supply from the Missouri river was presented to the then Board

3. *Pumping Station at Chain of Rocks*

of Public Improvements, by the present Water Commissioner in November, 1912. In this report Mr. Wall outlined a plan for increasing the capacity of the then existing works from 100,000,000 to 150,000,000 gallons per day, which he estimated would be ample to take care of the needs of the city until 1923, and also presented his recommendations for providing for an adequate supply after that time. The Board of Public Improvements finally approved the plans to bring the capacity of the works up to 150,000,000 gallons per day and funds amounting to $2,648,000 were provided to take care of the following improvements, all of which were practically completed before April 1, 1915.

4. *Intake Tower No. 1 in Winter*

New intake tower, tunnel and screen chamber; reconstruction of boiler plant and installation of coal and ash handling machinery at the Chain of Rocks; revetment of about two miles of river bank above the intake tower along the Illinois shore; mixing conduit and grit chamber with changes in basins, etc; 160,000,000-gallon filter-plant and head-house; generator house with equipment to provide power for entire Chain of Rocks plant; reconstruction of boiler plant, etc., at the low-service station, at Bissell's Point; reinforced concrete conduit between storage basins and pumps at the low-service station, Bissell's Point; miscellaneous buildings railway stations, shops, etc.

These additions not alone improved, but also increased the clarification capacity to 160,000,000 gallons per day, so that in 1915 it was possible to send an abundance of water, sparkling clear and free from disease-producing bacteria, to the clear well at the Chain of Rocks. Having attained a desired clarification capacity, the next step was to increase conduit, pumping, distribution and clear-water-storage capacities to the came as the clarification capacity. With this end in view, Mr. Wall, in 1915, recommended the reconstruction of Compton Hill reservoir (built in 1870); the building of an additional clear-water-storage reservoir at the high-service pumping station at Baden; additional pump mains from the high-service pumping station at Bissell's Point to Compton Hill reservoir; an additional conduit from the Baden high-service pumping station to the Bissell's Point high-service pumping station; additional pumps at the high-service pumping station at Bissell's Point, and as a sanitary measure, the covering of the clear-water-storage reservoirs and basins at Baden, Bissell's Point and Compton Hill. The cost of these improvements was estimated at $3,600,000, but appropriations were not made for all the items, and this fact, coupled with the delays incident to working conditions during and following the war, made it impossible to carry out the entire program as originally laid out.

5. *Coagulant House*

Of the major recommendations made by Mr. Wall in 1912 and in 1915, there are in abeyance at this time, a clear-water-storage reservoir at Baden; the covering of all clear-water reservoirs and basins; additional pumping units at the Bissell's Point high-service pumping station; and additional pump mains from this station to Compton Hill reservoir and into the distribution system.

The complete method of operation from the river to the consumer may be briefly described as follows:

Water is taken thru either one or both of the intake towers at the Chain of Rocks and passes thru either one or both tunnels to the screen chamber and wet well. From the wet well, it is lifted by the low-service pumps, an average of 48 feet and delivered to the delivery well, passing from here to the grit chamber where the velocity is reduced sufficiently to permit of the deposit of sand and heavier matter in suspension.

From the grit chamber, the water flows thru a short conduit to the lime-mixing conduit receiving a proper charge of lime just as it enters this conduit, which is so designed as to permit of a total travel of 9528 feet, insuring a thoro mixing of lime and water. As the softened water leaves the mixing conduit, it receives the proper charge of a solution of sulphate of iron and flows into the filling conduit and passes to the preliminary sedimentation basins, where from 95 per cent to 99 per cent of sediment and bacteria are deposited. It is then drawn off into a collecting conduit, measured by venturi meters and passes on to the secondary coagulation chamber, receiving a proper charge of sulphate of alumina in solution before it enters the chamber. From the secondary coagulation chamber it flows into two secondary sedimentation basins and thence on to the filters. After passing thru the filters, the water is collected in a clear-water conduit, delivered to the drawing-conduit chamber where chlorine is applied and then on thru two conduits leading to the clear-water-storage reservoirs at the high-service pumping stations at Baden and Bissell's Point, where it is pumped into the distribution system.

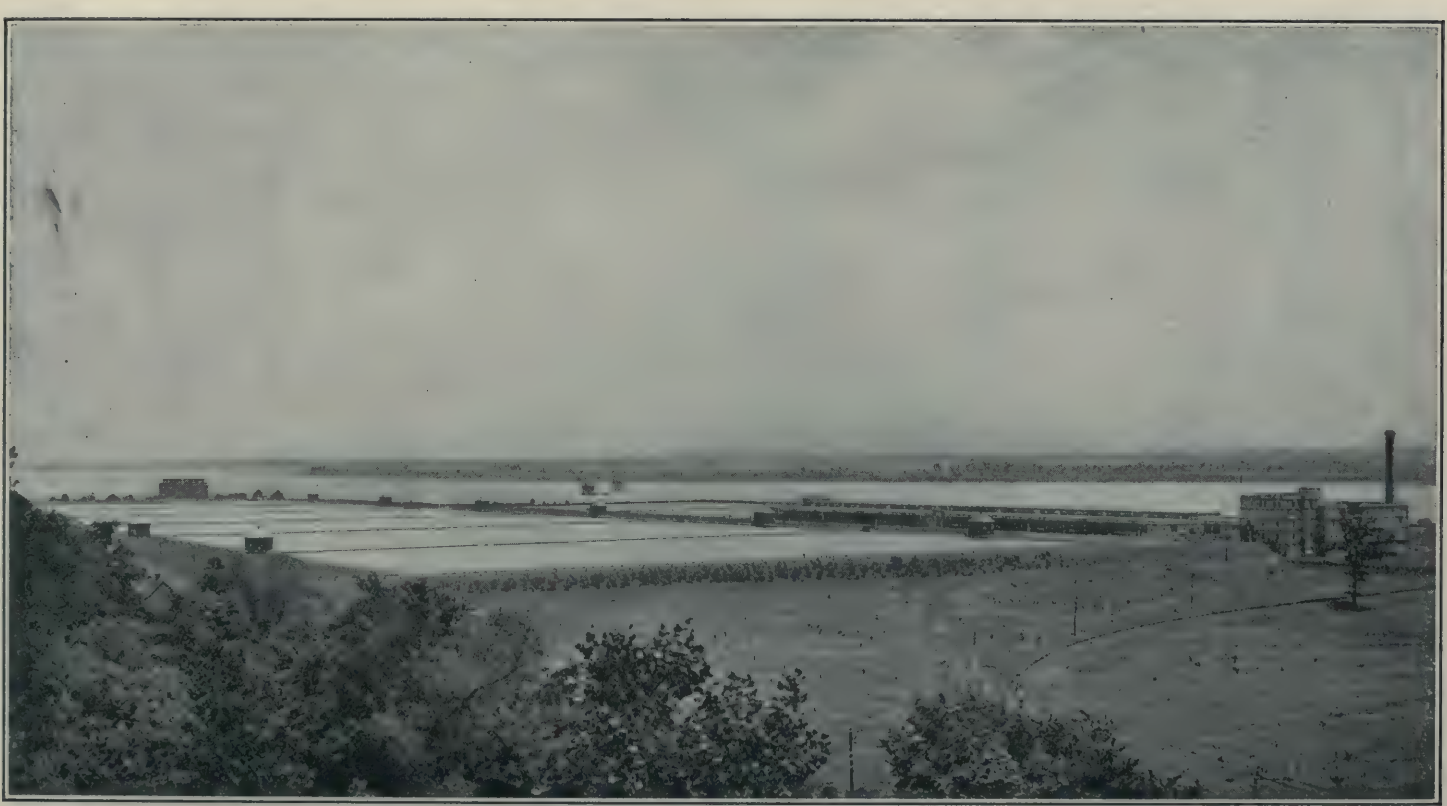
6. *Intake Tower No. 2*

The present scheme of clarification and purification in all its details is the result of over ten years of experiment and study of the treatment of Mississippi river water by the engineers and chemists of the Water Division. Many of the processes involved are original and in some cases precedents were set aside and the new ideas heretofore untried were put into effect.

All the apparatus used in the coagulant house was designed and built by water-works department men and is largely original, and the result of experiment over a number of years.

The filter plant also is of modern design and embodies many features not found in other plants. Much of the equipment was specially built to meet the specifications of water-works department engineers.

Careful attention is paid to the chemistry of water purification. The chemical laboratory is well equipped and careful determina-



7. *Settling Basins and Filter Plant at Chain of Rocks*

8. *Interior of Filter Plant*

tions are made of the proportioning of the chemicals used in the treatment. Daily tests are made on samples of water taken not only from the basins, conduit, etc., but also on samples collected from house taps in various parts of the City.

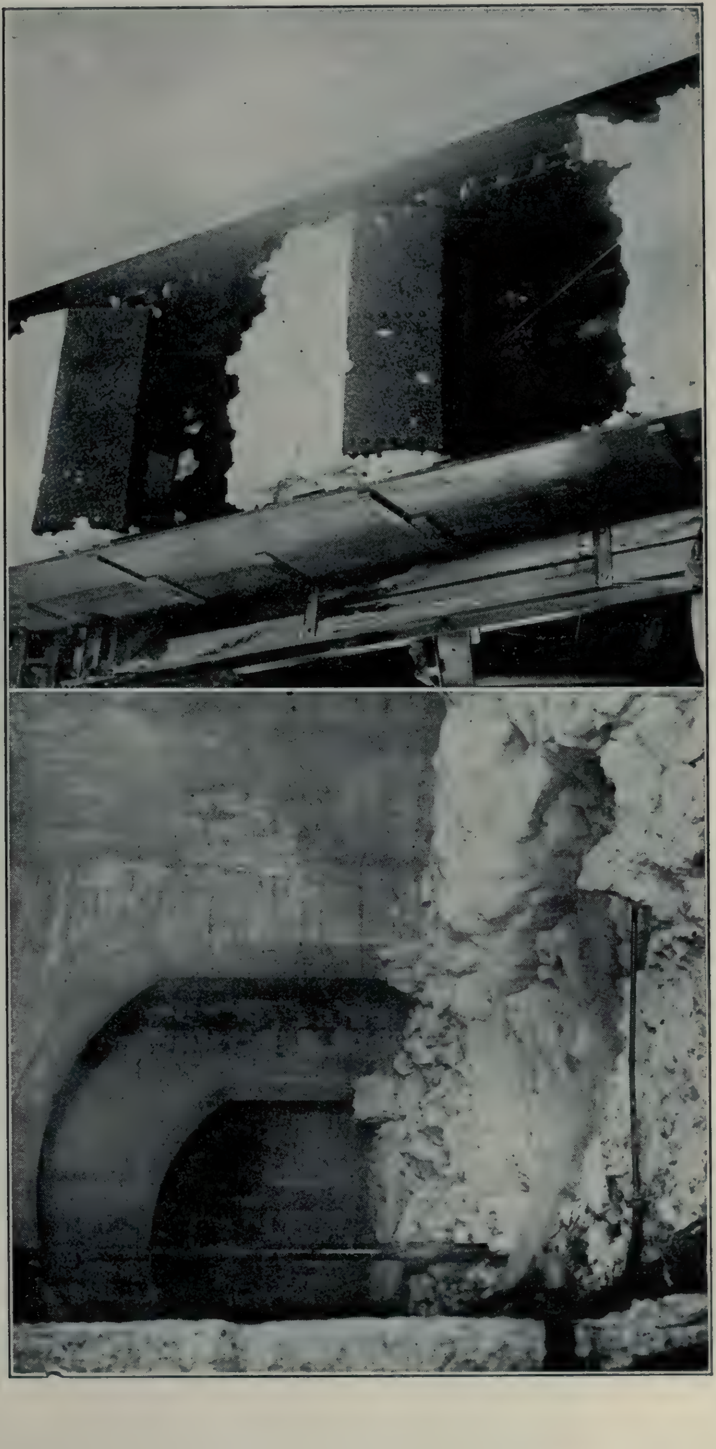
The present (1920) facilities for furnishing water and the daily capacities are as follows:

At the low-service pumping station at the Chain of Rocks, there are four Allis-Chalmers vertical compound engines, two of them built in 1895 and two in 1898, each of 30,000,000 gallon capacity; two DeLaval twin centrifugal steam-turbine-driven pumps, capacity 40,000,000 gallons, built in 1912, and one DeLaval centrifugal steam-turbine-driven pump built in 1918, capacity 100,000,000 gallons, six National and two John O'Brien water-tube boilers with a total rated horse-power of 2600. The safe working pumping capacity of this station is 200,000,000 gallons per day.

At the high service-pumping station at Baden, there are six E. P. Allis & Co. triple-expansion high-duty engines, two of 10,000,000 gallons and two of 15,000,000 gallons capacity built in 1898, and two of 15,000,000 gallon capacity built in 1902; eight John O'Brien water-tube boilers with a total rated horse power of 3200. The safe working capacity of this station is 55,000,000 gallons per day. At the high-service pumping station at Bissell's Point, there are three Allis-Chalmers vertical triple-expansion high-duty engines built in 1903, 1904 and 1905 successively, each of 20,000,000 gallons daily capacity; two Holly vertical triple-expansion high-duty engines built in 1914 of 20,000,000 gallons daily capacity each and one Cameron two-stage centrifugal steam-driven turbine built in 1915 of 20,000,000 gallons daily capacity; four W. T. Geary, six Heine safety and two John O'Brien water-tube boilers with a total rated horse power of 2800. The safe working capacity of this station is 75,000,000 gallons per day. All boiler rooms are equipped with coal and ash handling machinery.

From the Chain of Rocks to Baden, there is a safe conduit capacity of 200,000,000 gallons per day and from Baden to Bissell's Point, the safe conduit capacity is 140,000,000 gallons per day. The capacity of the clear-water-storage basin at Baden is 25,000,000 gallons, while the clear-water-storage capacity at Bissell's Point is 54,000,000 gallons. The outlets from the high-service pumps at Bissell's Point, altho improved by reason of a very flexible manifold arrangement, are not yet sufficient to care for peak-load conditions.

It is evident from these figures that the low-service pumping, the clarification, conduit and boiler capacities have been developed in accordance with plans suggested by Mr. Wall in 1912, but that the high-service pumping, clear-water storage, and distributing capacities must be increased in order to complete all of the recommendations made at and since that time, and to properly balance the working output capacities of the several different stages of treatment from the raw water to the finished product.



9. *Ice in Wet Well and Method of Removal by Bucket Conveyor*

Among some of the vexing problems may be mentioned (1) Difficulty of maintaining normal pressure at times of peak loads, at which time the consumption reaches a rate as high as 180,000,000 gallons per day or 7,500,000 gallons per hour. (2) Difficulty of keeping tunnels and wet well at the Chain of Rocks free from needle and slush ice. (3) Difficulty of maintaining proper standard of excellence of clear water stored in open reservoirs.

In addition to furnishing the water supply for the city, the Water Division has developed and now maintains a park at the Chain of Rocks and one at Compton Hill Reservoir. These parks are in addition to the customary landscape work around all the pumping stations, the filter plant and basins. It also maintains a railway between Bissell's Point and the Chain of Rocks with yards at each of the three pumping stations. Electric cars operated on a fixed schedule for convenience of employees and also for other passengers and package freight. Carload freight, chiefly chemicals used in treatment of water, coal and construction materials, are handled with steam locomotives.

The water works are under the control of the Director of Public Utilities, who with the Directors of three other Departments and the President, form the Board of Public Service. The Director of Public Utilities is appointed by the Mayor for a four-year term and must be an engineer of technical training, of at least ten years experience and qualified to design as well as to direct engineering work. The Water Division is under the direct charge of the Water Commissioner, who is appointed by the Director of Public Utilities, and who must be a duly qualified engineer of at least ten years experience in responsible charge of engineering work, and who is qualified to design, construct, operate and maintain all machinery, apparatus and appurtenances necessary for the water supply of a large city. There are, in addition to the Assistant Water Commissioner's office, four main sections; the Supply & Purifying, Operating, Distribution, and Assessment, each in charge of a chief engineer except the Assessment Section which is in charge of a chief supervisor. Altho the Water Division renders bills for water service, all collections are made by the Collector of the Revenue. The collections from all sources for the year ending April, 1920, were $2,625,916.95. The cost of the works to date, $33,000,000.

Altho but passing mention has been made of the Distribution Section, it is a fact that this branch of the Water Division is well designed and maintained. The main feeders are 36-inch and 30-inch diameter, the auxiliary lines, 20-inch and 12-inch while the minor distributions are 6-inch and 8-inch. Shut-off valves are conveniently placed and fire hydrants are set at frequent intervals. There are five supply yards or service stations, including the main pipe yards, where shops, store-rooms, etc., may be found.

Unfortunately, only about eight per cent of the services are metered and altho the per capita consumption is not as great as in other unmetered localities, the unnecessary waste is large enough to justify the adoption of a plan for universal metering. Failing in this, it will be necessary to begin within a very short time a program for the construction of new works in accordance with the scheme suggested by the present Water Commissioner in 1912.

THE PRESENT STATUS OF THE ACTIVATED SLUDGE DISPOSAL PROCESS

By Edward Bartow, Head of the Chemistry Department, State University of Iowa, formerly Director State Water Survey Division, Urbana, Ill.

The title assigned for this paper is too inclusive and the time available for the preparation of the paper has not been sufficient to properly discuss the activated sludge problem at the present time. As an illustration of this fact, I am informed by Mr. J. Edward Porter, who prepared a bibliography of the activated sludge problem in 1917 and is revising that bibliography at this time, that there will be over 600 titles in the revised bibliography to be issued early next year. In this paper, I can only hit some of the high places in the time allowed this morning.

In 1916 Geroge T. Hammond presented a very complete history of the activated sludge process before this association. He described very completely the work that had been done thruout the country. Shortly after that time, owing to war investigations, the experiments diminished to a considerable extent, so that while there are a large number of additional articles, most of them are quite recent.

Having had an opportunity to visit some of the installations in England and in this country, I am proposing to describe some of the installations seen, which include what I believe to be the largest and best plants. Thru the courtesy of J. C. McVea, chief engineer of the city of Houston, who has very kindly furnished me with several pictures of one of the Houston plants as it is today, I am able to give some information concerning that plant. The Houston plants are the largest in this country and also in the world that have been in successful operation. They consist of aeration chambers, settling tanks and large air compressors in the building at one end of the tanks. On the hill above the plant are buildings in which sludge-pressing and sludge-drying experiments are being made. This plant has been described more in detail elsewhere. Suffice it to say that a very satisfactory effluent has been obtained. The sludge has been disposed of by lagooning and up to the time of the presentation of this paper the methods for dewatering and drying the sludge have not been perfected.

The first plant of any size was built at Manchester in 1914 and has been in operation since that time. It is operated on the fill-and-draw system and has a daily capacity of about 50,000 gallons. It is built in one corner of the settling tanks used in the sewage disposing system of the city. As a result of the experiments with the fill-and-draw system, the city of Manchester, Rivers Department, constructed a plant on the continuous flow plan at Withington works, having a capacity of about 500,000 gallons daily. In this plant the sewage passes five times the length of the tanks and the sludge is returned through a pipe to the point where the sewage enters the tank. The mixed sewage and sludge passes to the center of the settling basin and the clear effluent flows out over the edges of the tank at the corners in order to prevent short circuiting. The results obtained at the plant at the Withington works have been so satisfactory that a much larger plant has been constructed at the Davyhulme works. The sewage and sludge in this case passes three times the length of the plant and the sludge is returned to the entrance in an open channel of half the width of the aerating channel. For experimental purposes two kinds of settling tanks have been constructed; one for gravity separation having a sharply sloped bottom so that the sludge may settle to the center of pyramids and be removed by gravity; the other having a circular bottom sloping only slightly and so planned that the collecting mechanism will carry the sludge to the center to be removed from that point.

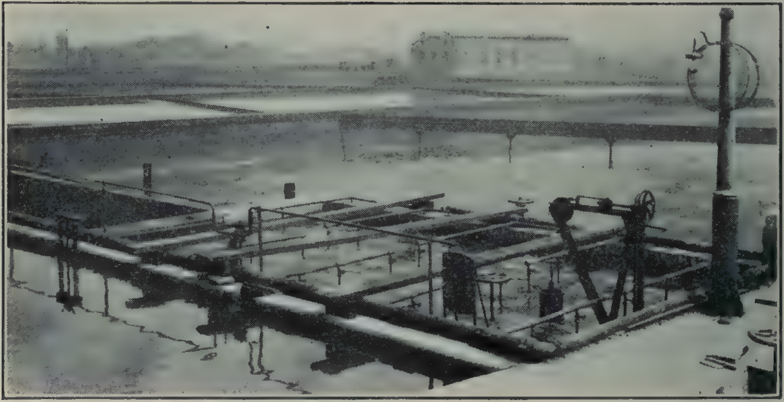
1. *Withington Activated Sludge Plant for Manchester, England*

The activated sludge plants at Manchester have been the largest and most successful in England. A description of these plants will be found in the reports of the Rivers Department of the city of Manchester.

The plant at Worcester, which is adapted from former purification tanks, has also been successful and it is said that the activated sludge process will be adopted for the treatment of all of the sewage from the city of Worcester.

During the war, several small plants were constructed at hospitals and munition plants. One at Blackpool takes care of the sewage from the munition plant, employing 3000 men. This plant was cared for by regular employees of the plant in connection with or in addition to their other duties so that the expense for labor at the small plant was almost negligible.

In the United States, aside from the plants at Houston, most of the activated sludge plants are experimental. The experiments which have been made by the city of Milwaukee, and by the Sanitary District of Chicago, which have been mentioned by Mr. Pearse, have led to the adoption of the process for much larger plants. The Sanitary District of Chicago has a large unit under construction at Maywood. A large plant will ultimately be built to dispose of the waste from the stock yards and one will be constructed in the Calumet district. Experimental work is being carried on with the disposal of wastes from stock yards, tanneries and from a starch factory.



2. *Fill-and-Draw Plant for Manchester, England. Original Activated Sludge Plant at Davyhulme*

At Milwaukee preliminary experiments have been completed and at the present time they are especially interested in settling the problem of sludge drying in order to determine the proper designs to adopt in their large scale treatment plant.

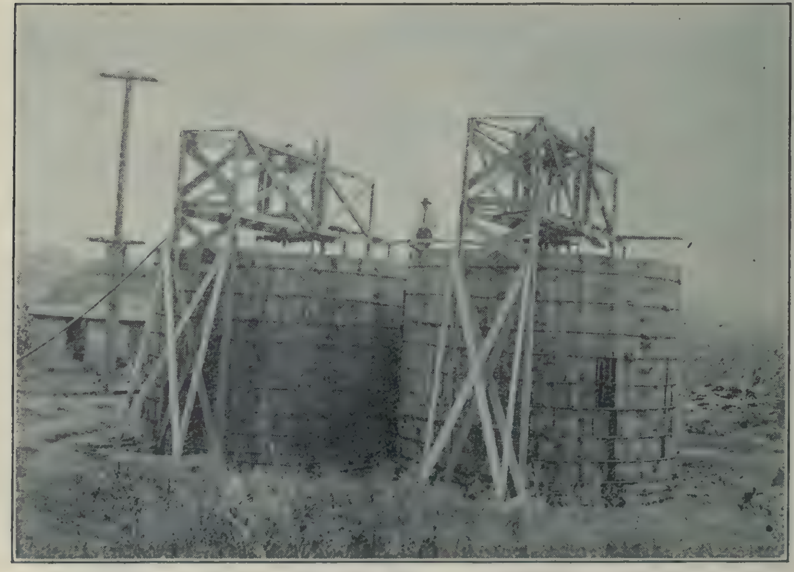
The state water survey division at Urbana with a small appropriation has established an experiment station which is being put in operation at the present time. In this it is proposed to have a plant as complete as possible. It will have approximately 100,000 gallons daily capacity and will include screening, aeration, sludge dewatering and drying.

The sewage flows by gravity through the grit chamber to a screen furnished by the Dorr Company of New York. After screening, the sewage passes to the pump pit from which the screened sewage is pumped to the aeration tanks. By use of screened sewage trouble from stoppage, which often occurs when unscreened sewage is to be handled, is avoided. The activated sludge plant itself contains 2 tanks 17 feet in diameter and 13 feet in depth. The sewage may pass thru in series or in parallel. It is expected to use the plant in a manner similar to that used by the Dorr Company, in an experimental plant at Mount Vernon, N. Y. About half way between the top and bottom of the tank is a tray inclined slightly upward toward the center. Air is forced in thru filtros plates at the bottom and is caught and carried to the center of the tank under the tray. The air rises thru the central well and is returned with the incoming sewage thru another well to the lower compartment of the tank where it is carried by a revolving mechanism to the outside toward the outer rim of the bottom of the tank where it passes over the plates and is caught up by the air and carried with the air to the top, thus completing the circuit.

3. *Aeration Tanks of Activated Sludge Plant at Worcester, England*

At the top, part of the mixed sewage and sludge passes over an adjustable collar into the upper part of the tank, which is a settling compartment. The clarified liquid passes over the outer edge into the trough from which it passes to a second tank, or to a stream. The sludge is carried by another mechanism to the outside of the upper chamber and flows by gravity thru downcast peripheral wells into the lower chamber where it is mixed with sewage and air and enters the aeration circuit.

4. *Grit Chamber and Screen at Experimental Plant, Urbana, Ill.*

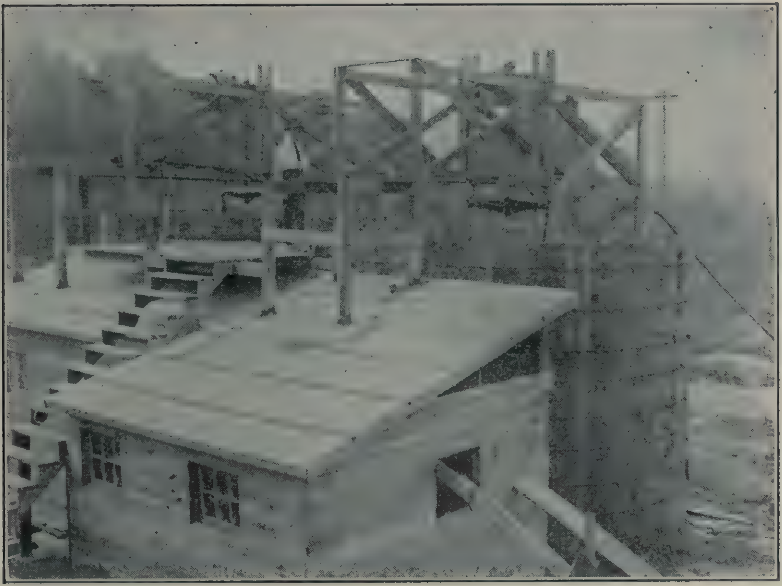


5. *Activated Sludge Tanks, Dorr-Peck Process, at Experimental Plant, Urbana, Ill.*

We thus have two circuits; one for sewage, sludge and air and the other thru the sedimentation section of the tank for the sludge alone.

It is hoped by this method to demonstrate what was shown by the Mount Vernon test, that the amount of air used can be greatly reduced.

The two important problems of the activated sludge process which have not been satisfactorily solved are the amount of air used and the drying of the sludge. By the Dorr-Peck process it is proposed to reduce the amount of air. Two other proposed methods should be mentioned, both English. In one it is proposed to use the air intermittently. Sufficient air will be added to saturate the mixture of sewage and sludge, then the addition of air is discontinued for a while until the air is used up. In the other, the scheme which has been adopted for the new plant at Manchester, the air comes in at one side of the long tank and is expected to cause the sewage and sludge to circulate in a direction horizontal to the line of flow thru the tank. The portions of the tank at the sides farthest from the aerating plates have a curved bottom and it is expected that the circulation will be such that the amount of air required will be greatly reduced.



6. *Compressor and Pump House in Experimental Plant, Urbana, Ill.*

The other problem not satisfactorily solved is sludge drying and it is my thought that many cities which have been considering methods of sewage disposal have hesitated to adopt the activated sludge process because of the difficulty in disposing of the sludge. Because of the expense, engineers have advised against its adoption by several cities. Where possible, if the amount of air could be decreased and the sludge satisfactorily disposed of, the method might be found the most satisfactory and the cheapest.

At Milwaukee the Sewerage Commission has spent a great deal of time and energy in an attempt to solve the sludge disposal problem. At the present time they have installed and are testing a continuous centrifugal machine and it is sincerely hoped that it may prove satisfactory and successful. Aside from the centrifugal machine, plate presses seem to be most promising.

For the final drying aside from attempts to dry the sludge on sand beds most attempts have been made by direct-heat driers. Recently, the Bailey Mfg. Company in Milwaukee has designed an indirect-heat drier which is to be tried at the sewage testing station at Urbana. In preliminary tests with this drier, a sludge with less than 10% moisture was obtained from the sludge having originally nearly 90% of moisture. There was no unpleasant odor and no dust noted during the process. Drying without odor or dust has not been accomplished with direct-heat driers and it is hoped that the expense of the indirect-heat driers will not be too great and that it may solve the problem of sludge drying.

In closing I wish to place a final emphasis on what seem to me to be two important problems in the activated sludge process at the present time, namely reduction of air and the drying of the sludge, with the hope that the problems may soon be solved.

DISCUSSION

MR. BEACH: The operating charge is of course an important item in the case of a rather small plant. Has Dr. Bartow settled in his mind the problem of size?

DR. BARTOW: Each plant must be considered in accordance with local conditions. Before seeing the plants in England I had fixed in my own mind, without exact figures, about 2,000,000 gallons a day, serving 20,000 people, as the minimum capacity, but some English plants visited and others heard of indicate the possibility of smaller plants, especially for manufacturing establishments whose engineers can devote a part of their time to the plant.

MR. PEARSE: You might be interested to have brought before the Convention a concrete case that Mr. Greeley, Mr. Hansen and myself recently had in making an estimate for a town of fifty thousand in the state of Illinois. The cost of sprinkling filters was $630,000 and the activated sludge $540,000. The annual cost for operating, exclusive of interest, is vastly different. You can see on the construction cost that activated sludge, including pressers and driers, would be between 0.8 and 0.9 of the cost of sprinkling filters. On the other hand, the operation of the sprinkling filters is only going to cost $21,000 exclusive of interest, whereas the operation of the activated sludge plant will cost $81,000 or with certain allowances for economies and sludge, a possible $56,000. In other words, it is going to cost 2½ times as much to operate the activated sludge at the minimum, and 3½ times as much on the gross cost. The interest charges are almost the same under the present post-war conditions. If, however, you were to cut the amount of air down, as claimed by the Dorr Company for their apparatus, you would still have $51,000. These figures are based on 2 cents per kw.-hr. In other words, there is no chance, with our present knowledge, under the present conditions, on this size of plant to bring the cost of activated sludge down to a par with tanks and sprinkling filters on a total annual charge.

We have to find other refinements, either in minimum tankage or minimum use of air, or improvement in the sludge handling, to make it attractive, where the problem has to be settled on a financial basis. In our case in Chicago at the Stockyards and Packingtown we have a peculiar condition, and I think Mr. Hatton has in Milwaukee, which justifies perhaps a greater expense from an operating standpoint than would otherwise be the case. We have to take the suspended matter out at the point of origin. It is to our advantage to handle it at the point of origin, which means we can do business on from 10 to 12 acres and recover some matter that may have value to the packers.

In the smaller outlying problems, the decision generally rests on the cost of operation. I think there is still need for experiment both on the use of air and size of the tanks and handling of the sludge. I think Mr. Hatton will bear me out when I say the question of handling sludge is not so much a matter of machinery, at present, but of finding how to condition the sludge so that the water can be readily extracted. It is very easy to take the water out if the sludge is right. The difficulty is the material has so many finely divided particles which retain the water. I think there is a big field for the chemist to work out something that will materially help in the mechanical handling of the problem.

MR. HATTON: The gentleman was inquiring about the comparison of cost of sprinkling filters and activated sludge. Mr. Pearse's discussion in the matter brings this thought to my mind, which always comes to my mind when these discussions come before a public body. Mr. Pearse has practically answered the question. Sanitary engineers who have been investigating as to its comparison with the sprinkling filter, as to the cost, say that they are absolutely two different processes. Which process is to be used, must be judged by the conditions. There are lots of places in the country where the activated sludge process would be an improvement.

Everybody who is working with sewage disposal in any manner, in large cities, knows that the real problem is the final disposition of the sludge. In our community, we have no way visible to get rid of sludge. The United States Government engineers took the attitude that we should not dispose of it by dumping it into the lake. Our citizens were opposed to doing that. We could not dispose of our sludge in the country districts. It was suggested that we haul it into the country and turn it into fertilizer. As in many districts, the farm districts are jealous of the city, and it would not take very long for the farmers to get together in the legislature and prohibit the city of Milwaukee taking its filth and dumping it in the country. Now, there are lots of other cities in the United States that have the same condition.

There is another thing that must not be overlooked and that is, in all other processes of sewage disposal, the sludge produced has a very much lower value of ammonia than in the activated sludge process. In the city of Baltimore, where they are reducing the sludge from their plant to a fertilizer basis, they get about and rarely over 2% of ammonia in their finished product. We get at least 4 and as high as 7. At the present time, those units are worth about $6. It was worth a little over $7 during the war. We are informed by very creditable fertilizer people that it will never go down to the price before the war of $2.50.

Now, we produce a ton of dry material from 1,000,000 gallons of sewage as a minimum. We are estimating that we will have 4 units of ammonia in our sludge, after it is dry. That will be $16 to $18 return from the sale of the sludge from each million gallons treated.

From the best estimates that we have made, and this is in answer to your question, sir, under this high cost, and where every bit of our plant has to be put on pile foundations, and where all of our land has to be reclaimed from the lake by building dams and filling in the ground, the most expensive kind of construction; and estimating overhead charges, such as interest, sinking fund, etc.; all operating charges so far as we can see them; the cost of operation will be $35 per 1,000,000 gallons. Deduct eighteen dollars, the estimated value of sludge produced, from that and you will get $17 per 1,000,000 gallons.

I might divert my remarks just a moment to say that in most of my examinations as to the cost of operating other sewage disposal plants, those who publish their reports unfortunately leave out the overhead charges such as interest, sinking fund and that sort of thing, so there is very little information I am able to get on which I could base the comparison. I will say that the best information I am able to get is that sprinkling filters will cost about $15 per 1,000,000 gallons. That is approximate.

It is true that the largest cost of operating an activated sludge plant is the cost of power for compressing the air used. We are estimating it at 1 cent per kw.-hr. We produce ours rather than buy it, altho we have a tentative contract to furnish it for a little less than that by our own utility company.

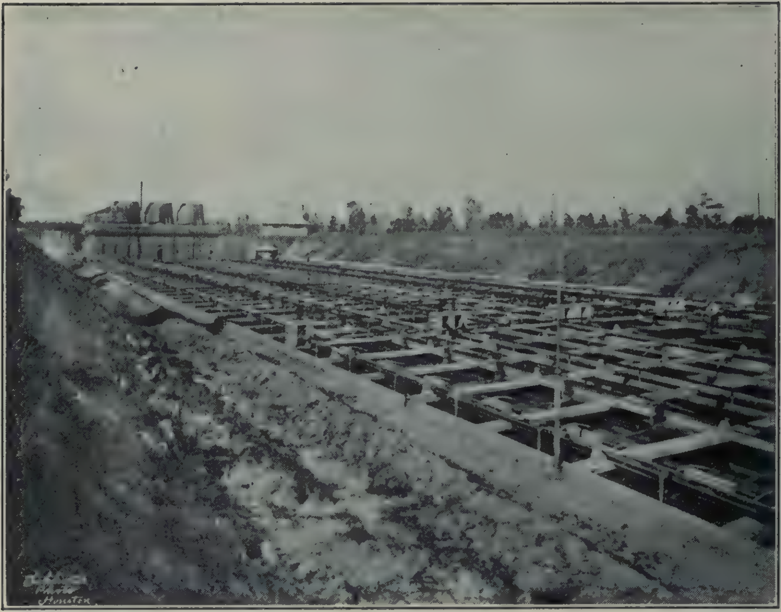
In line with what Mr. Pearse said as to the problem of the water in the sludge, I am sorry to say that the sludge-drying apparatus made in Milwaukee we tried out with our sludge and it was an absolute failure insofar as being applicable to a plant the size of ours. I do not want to discourage you, but it was. We have reached a point in the last six months where we can dry our sludge by pressing very satisfactorily thru any type of press we have there.

We have two types of presses and four types of plates, and we can get it down to 80 per cent moisture in an hour and a half in any of the types of presses we are using, but unfortunately, when the cold weather comes along, that is not a fact. The character of the sludge changes so decidedly that we have to extend the time of pressing up as high as five, six or seven hours, but we have no difficulty in getting it down to 80 per cent. We believe that six or seven hours is not a practical solution of the problem.

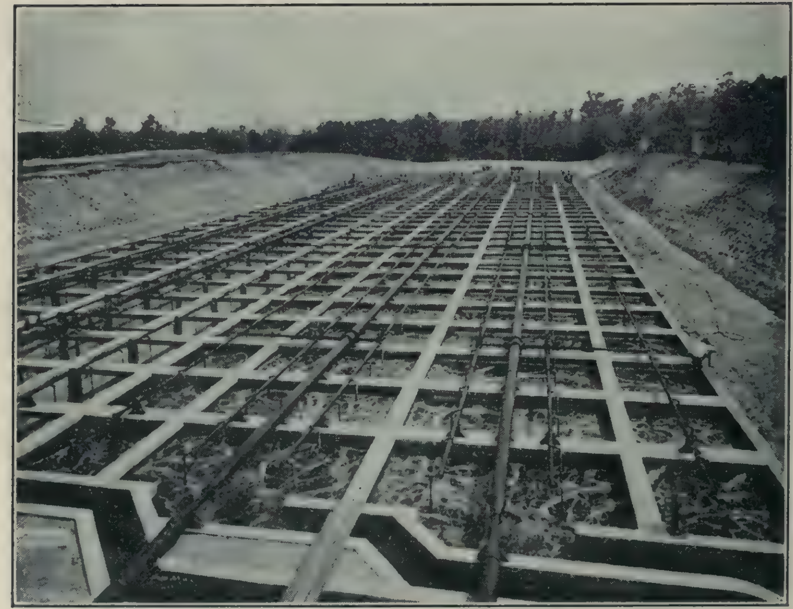
I have been very much interested in chemistry and I have engaged probably one of the leading chemists in this line in the United States to make a study as to what the real change in condition of the sludge is between the winter and summer months. He is of the opinion, so far as he has examined it, that the character of the sludge can be absolutely controlled, and that control is thru finding out what the neutral acid point in our sludge is, and controlling from that.

Now, to you gentlemen who are not particularly engaged in chemistry as applied to sewage problems, that is rather a blank, but colloidal chemistry is rapidly coming to the front and, in my judgment is going to have more and more effect on the proper disposition and disposal of sewage as we examine it. In fact, this sewage disposal game is far from being solved. We only feel that we have made some improvement. We have gone a step further ahead than sprinkling filters in the general disposition of sewage, but as far as comparing the two, do not do it, but just as Mr. Pearse and Dr. Bartow said, take up each particular question as it stands on its own bottom.

Mr. McVea: I may be able to give a few facts from the operation of our plants in Houston, that would be of interest to these gentlemen. We have two plants, one designed for handling 12,000,000 gallons per day, and the other 6,000,000. Our larger plant is now handling something over 6,000,000, and the smaller plant about 2,000,000. Our power rate is one cent per kw.-hr. We have no trouble in getting a clear and safe effluent. This is proven by the fact that one of our plants last June, a year ago, was overflowed by the stream nearby, and a number of fish and minnows were left in the settling and effluent channels. They continued to live there and flourish for a number of months, in fact, over a year. After that period, I saw minnows, perfectly healthy, swimming in those channels.



7. *General View of Activated Sludge Plant at Houston, Tex.*



8. *Aerating Tanks in Houston Activated Sludge Plant*

Our greatest difficulty at the present time is the handling of the sludge after running thru the presses. This is a very sticky substance, and we have not found a conveyor yet which would handle it in a proper manner. It gums up the conveyors, and will not drop off into the heating tube which was installed for the purpose of reducing the moisture content down to about 10 per cent.

I have a copy of our operating chart for the month of September and will mention briefly the results shown. The first item is the reduction of suspended solids, showing about 96–98% reduction. The rate of flow shown varies from a little over 6,000,000 gallons to 6,400,000 gallons per day. When it rains, we by-pass the flow into the channel, the dilution being sufficient to prevent creation of a nuisance, and on those days the chart shows no flow thru the plant. We continue to operate the plant, however, in order to preserve the activation of the sludge.

The amount of sludge in the re-aeration channels, based on 30-minute sedimentation, averages about 35%, sometimes just a little over 30, sometimes going to about 36%. The relative stability after 10 days incubation at 37 deg. C., is about 98%. Sometimes, however, that falls as low as 86%, only one day, however, showing that low.

The per cent reduction of oxygen consumed varies considerably. One day as low as 50% reduction is shown, and on another 55%, but as a general average, we have about 65 or 70%. The highest reduction shown here is 84% on one day of the month.

The nitrates in parts per million show considerable variation. It is hard to pick out an average from this chart; however, there is something like 40 to 50 parts per million.

The free ammonia in raw sewage in parts per million runs sometimes as low as 10, but I notice that occurs on only 2 days. The average is about 15 or 18. The ammonia in the effluent sewage in parts per million is about 5, and is fairly uniform.

The amount of air which we use is about 1.44 cu. ft., per gallon of sewage treated. That is distributed in this manner: To the sludge lift, .03 cu. ft. per gallon of sewage; in the main aeration tank, .94 cu. ft.; and in the re-aeration of the sludge, .47.

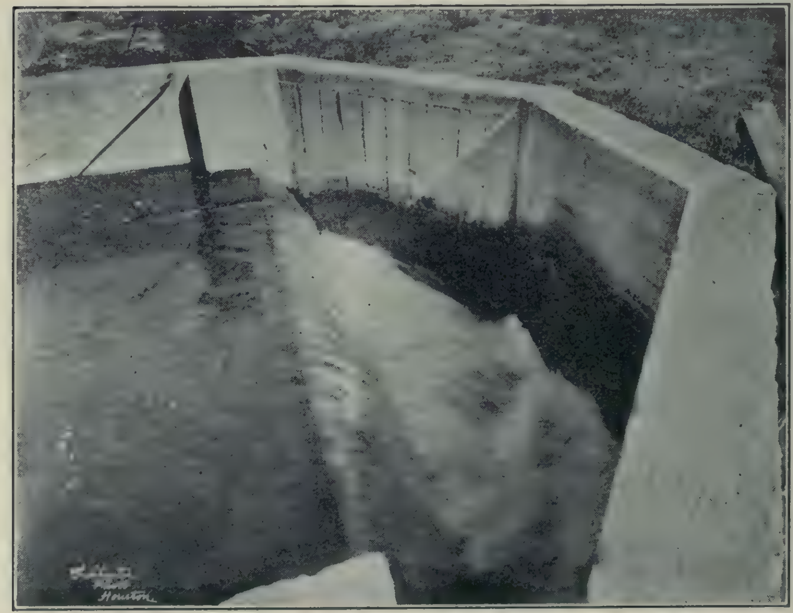
The average time in passing thru the aeration tank is 2 hr. 15 min. The average time of the re-aeration of the sludge is 4 hr. 40 min. That gives a total time of 6 hr. and 55 min.

The cost of handling the sewage for this month was about fourteen dollars per million gallons handled. We have not included any overhead. This is merely the operating cost of the plant.

PRESIDENT NORTON: Further discussion?

MR. HATTON: I want to bring out clearly that Houston is handling the sewage without treatment of the sludge.

9. *Settling Tanks in Houston Activated Sludge Plant, Showing Also Discharge Channel*



10. *Main Outfall Weir of Houston Activated Sludge Plant*

STREET LIGHTING IN ST. LOUIS

(Note: The following is a discussion of an interesting paper on this subject, copy of which was not furnished for the Proceedings, and the discussion is considered to be valuable tho the paper is not given.)

EARL A. ANDERSON of Cleveland, O.: I was very much interested in Mr. Toensfeldt's paper, especially his reference to the importance of emphasizing the appearance of a lighting system as well as the illuminating value. In the past, many street-lighting systems were designed and installed with the chief object of getting the light, therefore a large number of our existing lighting installations are not of the kind that cause the property owner to be glad if he has a lighting post falling in front of his house. I think a real test of any public improvement can be had by simply finding out whether the property owner is glad to have the improvement in front of his house or prefers it down the street. In St. Louis as in other cities that have given the appearance of the lighting post proper attention, it will undoubtedly be found that the property owners will each want a light post installed in front of his place. It has been a very common experience with the so-called "White Way" lighting, on business streets, that a merchant will feel bad if the lighting post comes in front of John Jones' instead of his store.

Now the theory of street lighting, that is, the amount of light which is necessary, and the exact distribution of it that is most desirable, as many of you know, has been a very mooted question for a great many years, and I was very interested to hear Mr. Toensfeldt's exposition of their choice here. The number of factors involved in street lighting is great, and I think the choice between the non-uniform versus uniform illumination on the street surface actually varies according to requirements of different locations.

Ten or fifteen years ago when there was comparatively little auto traffic, lighting systems were designed chiefly to make walking safer, and to make it easier to protect the pedestrian against crime. Now, especially on thorofares, I think there is a strong feeling that lighting to avoid traffic accidents is in many cases even more important than the prevention of crime, and I think this different purpose may, in some cases, change the general street-lighting design.

I was very much interested in noting the choice of a minimum mounting height of fifteen feet. I think that is a very great improvement over the ten foot mounting height of the old gas lights. In some cities street lights have been mounted as high as twenty-five or twenty-eight feet with very good results in getting the light up and out of the range of vision. I would favor a mounting height of twenty feet, if foliage from trees did not interfere.

Of course, the larger the size of the lamp and the farther apart they are spaced, the higher they must be installed, to obtain a reasonably even spread of light.

I would like to ask Mr. Toensfeldt what spacing they are using, both in the districts of less dense traffic and in the thorofares, and also the specific sizes of lamps that are planned for the different sections of the city.

MR. TOENSFELDT: I must say we have not worked out the details of the whole city. At the present time there is not money available. We have been working along as we could, but the mounting height for the ordinary residence street will be fifteen feet, principally due to the amount of trees, and the spacing probably one hundred twenty-five to the maximum of one hundred fifty feet. On boulevards, instead of alternating we are putting them down both sides, spacing one hundred twenty-five feet, approximately, for the same size lamp. On the modern business streets, we will probably go to twenty-two and one-half feet with a spacing of probably one hundred and fifty to two hundred feet. Downtown we will go to 1600-candle-power lamps and have four lamps to the block. The block lengths average about three hundred twenty-five feet, making the spacing from eighty to ninety feet. The mounting heights will be twenty-five feet.

MR. ANDERSON: If I might presume a little further on the time, I have a few lantern slides illustrating solutions of the street-lighting problem as worked out in Cleveland, which might be of interest to some of you gentlemen. In Cleveland there was, I might say, practically the same problem as you have here in St. Louis. Originally there were a great number of gas lamps which must be replaced sooner or later because the natural gas supply is decreasing quite rapidly. In the downtown section, there were the old carbon arcs which were quite out of date, and about five years ago were replaced by a system consisting of approximately 1200 incandescent lamps. The new lamps were spaced 85 feet apart on each side of the street and ran 1500 candlepower each on the principal streets, and 1000 candlepower on the side business streets.

This system provides an illumination ranging from about five-tenths of a foot-candle up to eight-tenths of a foot-candle, which is apparently a higher value than that proposed for St. Louis. However, it is not felt that five to eight-tenths of a foot-candle is too high, because if there has been any criticism in the business district it has been that more light should have been provided.

MR. RICE: I would like to ask whether it would not be possible to get effective lighting on that street with the trees near the curb by hanging the light in the center. I know it is being done in a good many smaller places, getting good illumination with the old type of incandescent light.

MR. ANDERSON: Where the trees join about twelve or fifteen feet above the surface, a fair solution is to suspend the light over the street. Even so, it is not easy to secure a good appearance and the lighting system is not as good an installation as with the lamps along the side, as the center lamps being low are directly in the line of vision of the driver. Where the trees are higher it works out quite well.

MR. BARTHOLOMEW: The second street shown, in my opinion, would be 10 or 15 degrees hotter, because of the radiation of the heat from the pavement, than would be the first street, and that is a question for discussion. It is very interesting and I am not sure, where a street is of great width, that it is wise to put the trees back of the sidewalk, insofar as a decent street goes. For good lighting I will admit that the second street is the better, but I am not convinced that, taking everything into consideration, the lights should come over and the trees go back and make a street that is not desirable.

MR. HATTON: I understand, if a proposed amendment to the Constitution is passed, there will be a committee on street lighting. I want to impress on the minds of that committee one thought that is well worth taking up for consideration before the next meeting. You know I come from somewhat of a socialistic town, and the socialists wanted for many years to own all the public utilities. They now own the street lighting system of the city, but not the plants which manufacture the current. Thus, they have had the system of street lighting in the city absolutely under control, and the members present who have had anything to do with street lighting, know how hard it has been to impress on the public utilities the necessity of laying out street lighting in a scientific way. They won't do it. They have not the scientific knowledge, apparently, and if they did have, they would not spend the money.

There is a scientific way of street lighting and the only way we can get it is by owning the street lighting ourselves and employing the best experience in the United States to tell us how to do it. It is not possible as long as the public utilities own the lights. The public utility furnishes the current, and it has made the greatest difference in the world in the illumination in our city, both in the residential section and commercial and industrial sections. Today, if you come to Milwaukee, you will find that it has one of the best, most scientifically designed systems in the United States. I do not say that because I am from Milwaukee, but it is a fact, and only a fact because the street lighting itself, that is the plan of street lighting, has been taken away from the public utility and placed in the hands of public engineers.

TWENTY-SEVENTH CONVENTION OF THE AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS
ST. LOUIS, MO., OCTOBER 12, 13, 14, 15, 1920

BUSINESS PROCEEDINGS

Tuesday Morning, October 12, 1920

The Convention was opened at eleven a. m., President George H. Norton presiding.

President Norton: Ladies and gentlemen, we have held our meetings in various cities, but I feel sure we have gone into no city in which better preparations had been made and a heartier welcome extended, than in this city.

We have with us Honorable Mayor Kiel of St. Louis, Mo. who will, I believe, extend to us a proper greeting.

Mayor Henry W. Kiel: Mr. President, ladies and gentlemen, it is my pleasure to be here this morning. I am glad to have the privilege of extending a few words of greeting to such an audience as this. We are glad you have chosen St. Louis as your meeting place. I think you will be benefited by your visit here, and I know we shall.

We have many things in St. Louis that will be of interest to an organization such as yours is, an organization that has for its purpose municipal improvements. We realize that your problems are rather severe. We know that you exert a great deal of effort to obtain that for which you are striving, better municipal improvements. We know, too, that it is the hardest kind of work to accomplish, because the expenses of such improvements must be defrayed by the collection of taxes, and the tax payer seems to think that the money he pays in taxes is worth a great deal more than the money he spends for luxury. The taxation phase of municipal government is indeed an important one, and if the tax payer could only realize how greatly he is benefited thru the efforts of men like you I know he would not be so reluctant to pay for improvements that will be of such unquestionable value to the community in which he lives.

The greatest difficulty is encountered in securing the cooperation of the people in your municipal enterprises. The greatest problem with which we have had to contend in St. Louis has been a lack of the necessary cooperation. We have on several occasions endeavored to pass bond issues whereby we could secure money for municipal improvements. Unfortunately, the law in this State requires a two-thirds majority to pass a bond issue. Last May we voted on an issuance of bonds for public improvements, but instead of passing it for the full amount, we were allowed only about four million dollars, an amount inadequate to meet the demands. The people must be educated to the necessity of public improvements, and a meeting of this kind will tend to accomplish their education.

I know that you are going to benefit St. Louis by the publicity which is being given to your transactions here. I know you are going to help us to make these necessary improvements. This is the day when people want something for their money. They want smooth streets to drive over, and they are entitled to them. The streets of our city, and of other cities, are practically as good today as they were ten or twelve years ago, but because of the increase in automobile traffic, the people of today have a better opportunity of observing the rough spots.

We must give the people better service, and put more effort and more money into the construction of streets. I do not believe we have even now reached the point where we have secured a perfect pavement. I think it is going to take time to devise a composition that will be a little more lasting than any we are using today. We have a great street in the asphalt street, and yet we know that in five, six, seven or ten years the asphalt street becomes badly worn. We thought we had a wonderful street in wood block. It wears out possibly two or three times in our lifetime. Now, there is going to be a better method devised, and perhaps your organization is going to be the one to find the better method. There never was a time when the American people could not keep up with any kind of emergency. You can always find a man in America big enough for any job that is presented.

We know of the wonderful developments that have been accomplished in the way of invention. Take St. Louis twenty-five years ago. It was a small village. Take New York twenty-five years ago and it was not much bigger than St. Louis is today. See the wonderful progress made by the American people. Take the aeroplane and submarine. In 1904 a prize was offered to anyone who could stay off of the ground for an hour in an aeroplane,—and the prize was never awarded. Look up in the air now and at ten in the morning you will see the plane carrying mail to Chicago. About one-thirty you will find one coming back. That is only the beginning of what we are going to do. It would not surprise me if, within the next two or three years, you men, instead of coming by rail, would be coming to our city by the aerial route.

These are just things that will happen—you cannot get away from them. They have happened before. When I was a boy I used to deliver messages from one office to another. The telephone was not in existence, and that was only thirty-five or forty years ago. Look into the future, and the wonders that will be accomplished by men and women like you, will surprise everybody. I hope you and I will be here to see them.

This is a great place, a good world. We have a lot of good people in it, lots of good people in St. Louis. They want you to come here and have a good time. They want you to feel at home, feel that your time has not been wasted. I heard a man say the other day in response to an address, that he was pleased indeed with the St. Louis people, he liked them. They all had kind faces. "There is the man, for instance, who just gave us an address of welcome. He has a kind face—the funny kind." Which reminds me that on one occasion out at the Municipal Opera last summer, where we had audiences of ten or twelve thousand people viewing productions of operas second to none ever brought forth on the American stage, the comedian, quite a popular fellow, seeing that one of the girls had been observing him intently remarked, "You gave me a funny look," to which she replied "You have a funny look all right, but I did not give it to you." (Laughter.)

We want you to feel while you are here that you are among friends and that we appreciate your coming here. We want to make you welcome, make you feel at home. There are a lot of things you cannot get here that you might want, altho if you know someone very well, there is no telling what might happen. There was a time when I could refer you to the wonderful breweries where they made four and one-half percent. The breweries are still there, but the four and one-half percent is gone. I do not know whether it is coming back or not, but if you want my own opinion—I hope it will. In the meantime, we are going to get along just the same. We are going to shape ourselves to the conditions as they present themselves, and we are going to abide by the will of the majority. That is the reason we are such a strong and wonderful nation. That is what helps us to win our battles, and makes friends of us when the battles are over.

We learned a lot during the war period, and I know we profited by it. We have discovered some of our weak spots. We know what we can do, and we know we can do more than we thought, and it is going to be beneficial to us. That period of trial and tribulation is a thing we look back on. We have things to look forward to, better and bigger things, and if we just apply ourselves, and do the best we know how, give the best that is in us toward the land of progress, from the laboring man to the highest official, if we will learn to do our best and give the best that is in us, we shall have better homes, more comfort, and shall accomplish things that will help future generations.

We must be idealistic to a certain degree, and at the same time practical. We must devise ideas and schemes, the accomplishment of which will benefit our fellow men. A great responsibility rests with you men with technical training who are contemplating this municipal betterment. You have a hard fight, because you are going to have opposition, but you must set your ideals so far, so high, that even though you fall short of your goal, you will, at the time, have accomplished a great deal.

I feel that I am taking too much of your time. I want to again express the pleasure it is to come here to greet you. I wish you success in your undertaking, and am sure that you will accomplish much that will benefit the municipalities in which you live. St. Louis is glad to have you here, and you are as welcome as the birds in Spring and the flowers in May.

PRESIDENT NORTON: I assure you, Mr. Mayor, of our appreciation of your sentiments. In our Convention arrangements, there has been one who has been so active, I think we should now hear from Mr. Kinsey, President of the Board of Public Service of St. Louis.

E. R. KINSEY: Fellow members, just as man to man, I want to tell you we are exceedingly glad you are here. We have other than personal reasons for being glad you are here. St. Louis has profited greatly through the activities of this Association, and St. Louis is going to profit by your presence here.

Our President has expressed appreciation of the efforts on the part of the Local Committee to make this Convention a success. Of course, we appreciate his appreciation. I say again, we are going to profit by your presence just as we have profited by other sessions of this Association. There has never been a meeting of this Association from its organization down to the present, when St. Louis did not send delegates to the meeting, and bring back from that meeting, something of great value to the City. We know here the value of this organization. Our Mayor knows of its value. Shortly after the last session, he wrote letters to several hundred mayors in the United States, telling them they would lose something if they did not send delegates to this convention.

We are going to profit by your presence here because it reflects on the solution of problems we have to meet here, as the Mayor has stated, and so, from purely personal grounds and selfish grounds, we are glad you are here. We are glad to feel assured that we are going to have a profitable convention. Therefore, I repeat once more, we are very, very glad you are here.

PRESIDENT NORTON: Gentlemen, I am sure the society appreciates this hearty welcome. As it is beyond the power of expression of your President to respond to this welcome, I would therefore call on our First Vice President, Col. R. Keith Compton, who will make a proper response to this welcome.

COL. R. KEITH COMPTON: Any member of this organization should feel honored when given the pleasant assignment to respond to the address of His Honor the Mayor and to accept the generous hospitality, which you, Mr. Mayor, have so kindly extended to the American Society for Municipal Improvements assembled in this its Twenty-sixth Annual Convention.

This Society was organized at Buffalo, New York, in 1894. Upon the call of several municipal officials a gathering of sixty representatives from sixteen cities, resulted in the organization of this Society. Our historians differ as to who really first conceived the idea of such an organization; two award this honor to M. J. Murphy, former Street Commissioner of St. Louis, while still another gives the honor to R. E. McMath, at one time President of the Board of Public Improvement of this city. Be these differences as they may, all agree that the city of St. Louis is the mother of this organization, that the city of Buffalo, the home of our honored President, is the birthplace and that either Mr. Murphy or Mr. McMath is the father of the organization. Whatever part may have been taken by officials from other cities in the organization of this Society, the wisdom of the conception of Messrs. Murphy and McMath has certainly been proven and we might well wonder if they had a common vision that over a quarter of century later a body of six hundred men representing two hundred and fifty-two cities, would gather in the very city wherein was conceived the idea of such an organization. Mr. Murphy was elected as the first President of this organization and we are not unmindful of the fact that in this city of its conception our Eleventh Annual Convention was held in 1904 and it is therefore particularly fitting that this, the Twenty-sixth Annual Convention of the American Society for Municipal Improvements should be held in the land of its conception and on the spot where an adventurous and enterprising Frenchman planted a flagpole at the junction of the two great waterways of the West in the year 1764 and whose descendants to this day no doubt recall with just pride his words while standing on a bluff in the midst of a wilderness, "I verily believe that we stand on the site of one of the future great cities of the world." The truth of this prophecy is evident and you can very justly claim the wonderful advantages of your city.

Even before the War of 1861 your city was easily the greatest one of the West. History shows that during that terrible conflict your city was strongly "Northern" thruout that period but sufficiently "Southern" to suffer with the South; that during that period not even my own city of Baltimore, on the border line between the North and the South, where families were divided in sentiment, father against son and brother against brother, became darker or more bloody ground than St. Louis when the Civil War set the Mason and Dixon Line afire. Passing thru that great crisis with honor, you have indeed become "The Crossroads of a Continent, The Center of Centers," a great metropolis situated on America's greatest inland waterway and containing a population of over three quarters of a million people.

The people of St. Louis have sound reasons to be proud of the great progress which your city has made in growth and development. The increase in population from 575,000 in 1900 to 687,000 in 1910 and to nearly 800,000 in 1920 tells of the steady advance which St. Louis is making.

We have noted, too, in studying your population figures that this advance has not been of a spasmodic character but one of healthy, steady growth, evidencing that your city is built upon a solid foundation of industrial and commercial advantages. That these advantages have been concentrated to an unusual degree in St. Louis is indicated by the great diversified business enterprises which have been built up here, as shown by recent figures which state that your city does a business of $150,000,000 a year in shoes, $110,000,000 in tobacco products, $30,000,000 in railroad and street cars, $40,000,000 in drugs and chemicals, $100,000,000 in hardware, $35,000,000 in woodenware, $25,000,000 in furs, $75,000,000 in foundry products, $40,000,000 in meat packing, $20,000,000 in vehicles, $16,000,000 in stoves and ranges, $10,000,000 in candy, $10,000,000 in hats and caps, $10,000,000 in trunks, $10,000,000 in carpets and rugs and over $200,000,000 in wholesale dry goods. These, of course, only refer to some of your larger business enterprises; but what most impresses us is the diversified character of the industrial and commerical undertakings which you have developed.

We are not surprised, however, at the splendid growth which your city has made when we take into consideration its ideal location, almost in the center of our great nation, with the thriving, teeming West all about it, making it a point thru which flows a goodly portion of the business of this section; while to the South you have an area which is developing at a remarkable rate and has valuable resources of mine, forest and field that are being brought into production at an ever increasing rate each year.

A most important factor making possible the splendid progress which you have made have been your remarkable transportation facilities, with great railway systems radiating in every direction and with the mighty Mississippi giving you the advantages of an inland port.

Our friends who reside in St. Louis tell us that you have a fine climate and all of the other advantages that go to make life worth while. We do not doubt any of these statements when we consider that you have over three-quarters of a million people who think the same way.

There are, no doubt, many other good things about St. Louis which we have not seen or been told about, but which we realize you must have in order to build up such a community as you have here today.

The purpose for which this Society was founded is to gather and to disseminate information and experience and to promote the best methods to be employed in the management of muncipal departments in all of their ramifications and activities in the construction of municipal works, by means of annual gatherings in the various sections of this country; the reading and discussion of papers and problems upon municipal improvements and by social and friendly intercourse at such gatherings; and to circulate among its membership by means of publications, the information so obtained. And so, Mr. Mayor and gentlemen of St. Louis, you will find gathered together in this convention a body of men whose forefathers may have had honorable differences in the past both in the halls of Congress and on the fields of battle, but whose differences have long since been healed by the strongest of bonds, that of Americanism.

You will not find us a body of strictly technical and theoretical men but rather one of broad and practical views. You will find combined with our active membership, an associate membership consisting of men engaged in every line of material and machinery industries allied with municipal public works, men who are not looked upon as mere vendors of materials, but manufacturers and allied agencies who have joined hands with the active membership in one common cause; that of efficient and economical manufacture, production and distribution which, coupled with the latest methods of design and construction, will most economically meet the demands of up to date and efficient municipal improvements and management.

You have solved problems in this city which will be interesting and educational for us. Our experiences in municipal activities will no doubt be of interest to you. The population of this country is surely and gradually making towards cities; they are the centers of population and demanding more and more each year in the matter of water, sewerage, public buildings, parks and street improvements. Traffic is becoming congested more and more. All of these matters constitute problems which the American Society for Municipal Improvements must ultimately solve.

Mr. Mayor, we accept the very generous hospitality which you so kindly offer us. We expect to enjoy every minute of this occasion and to carry away with us not only knowledge gained by association with your City Officials, who have accomplished so much, but the charm of a city which is in many ways, historically speaking, unique; a City which has made such rapid strides in her municipal and manufacturing activities as justly rank her among America's greatest commercial centers.

PRESIDENT NORTON: Now, I am sure we feel at home and are ready for the real troubles of the week. I would explain first that this is not the fault of your President. He would spare you this if he could, but the Constitution provides that the President at this time say something, and I will try to make it as brief as possible.

PRESIDENT'S ADDRESS

Captain George H. Norton, City Engineer, Buffalo, N. Y.

A year ago the remarks of our President relative to our position before the public were so excellent that their repeated reading will be better than anything which may now be offered.

Appreciation of the true value of the engineer and those who direct our great improvements has been greatly enlarged in the past few, trying years. Thru peaceful generations there had been built up a complex machine we called American Civilization. It had been planned and directed in its material elements by the faithful, but too silent, individuals such as are here represented. When the great crisis of war came the smooth running machinery of our construction, production and distribution became a clanking, groaning monster. When those who knew were asked who could re-arrange to meet the new conditions they at once knew and perhaps for the first time really admitted to themselves that the engineers and construction planners were the ones who were fitted to meet the great material problems of war.

So much has been to our advantage as a class.

When we seek to hold our well-won place and more, to firmly establish our position, it is apparent that it must be accomplished not by any one means, but by occupation of the whole broad front on all available lines.

As individuals we must be ready to step out and occupy the position in our own community which we are trained to take, excepting for our modesty. We may combine in the various strong societies having definite lines of activity. But as a body of those engaged primarily in municipal improvements we must make ourselves so predominant in this line as to command the field of our work.

This Society has gone far in reaching this aim, but it has much farther to go.

We may well endeavor to make our society of today better known for what it is, but more, we must make it so much better that its light cannot be hidden. We are in a sound, healthy condition, but we may well increase our usefulness and influence. To this end we must have the active support and interest of every member, not only the counsel and guidance of the gray-heads to avoid pitfalls, but we must have the enthusiasm and youthful vision of our younger members.

However sound and wise may be the counsel of those who have learned from the long harsh experience showing in our gray hairs, we must admit that the enthusiasm of a new generation is necessary to carry us forward into wider fields. This, my plea to you as members, is that the younger men come forward in this convention and begin to take the places which they must soon fill, and in so doing prepare themselves to carry this Society into larger usefulness.

Some matters of detail in the operation of the Society have been brought up during the past year.

The first, was that of committee assignments. It had been brought frequently to my attention that some members had been on committees which were not along the lines of their own specialties and not as congenial to them as some other lines. After consultation with the Executive Committee it seemed well to appoint, so far as possible, committee chairmen who were actively engaged in direction of municipal work and this plan was followed so far as consistent with continued committee activity.

A circular letter was sent to active members asking their preference for committees, first, second and third choice. About one hundred replies were received. Again the innate modesty of our membership was shown by the fact that comparatively few of those who have held important committee positions made reply. So far as continuity of a committee's work would permit, choice was made from these expressed preferences.

As an indication of the desires of the members the following tabulation of preferences is given:

		First Choice	Second Choice	Third Choice
1.	Street Paving	10	7	6
2.	Parks	2	1	
3.	Planning	8	7	
4.	Traffic	2	4	4
5.	Lighting	1	1	1
6.	Street Cleaning	2	2	6
7.	Sewerage	12	7	3
8.	Water Works	4	6	3
9.	Legislation	2	2	1
10.	Fire Prevention	1	3	1
11.	Markets	1	1	1
	SPECIFICATION COMMITTEES			
12.	Asphalt	11	1	2
13.	Bituminous	4	3	1
14.	Broken stone		1	1
15.	Brick	9	1	2
16.	Concrete	3	3	5
17.	Stone block	3	1	1
18.	Wood block		1	1
19.	Sidewalks	2		3
20.	Sewers	3	2	5

The President regrets that he was unable to meet the expressed desires of all.

Another matter which has received material consideration is that of the relations of the associate with the active members in our Society machinery.

During the year this matter was brought to the President's attention in a most kind and tactful manner by one group of our associate members. This matter was at once laid before the Executive Committee and the views of several received. The discussions led to some amendments being presented and the whole matter has been carefully considered here by the Executive Committee and their decision will be made known in their report.

The principal points raised were the prohibition of the constitution against associate members addressing the convention without permission; the desire for representation on committees and for the authority for action in convention on specifications not in accord with committee reports. These cannot now well be discussed but the correspondence with the Executive Committee, all men of executive experience, has shown the kindliest sentiment toward the associate members and a desire to co-operate to the fullest extent, consistent with the welfare of the society and maintenance of their independent integrity as municipal executives.

The question of scope of committee work has received discussion; suggestions having been made for some additional committees. Those who have such in mind as meeting their especial lines of activity should feel at liberty to suggest such in the way of a formal amendment to the constitution or resolution for appointment of special committees.

The financial condition of the society also needs our thoughtful attention. Like all non-producing institutions, the increased cost of operation is out-running a fixed income. No society can fully function unless properly provided with financial backing.

A material proportion of our membership is supported directly thru municipal or other public sources and should meet these added expenses as others have been met. We trust our associate members have been able to maintain their percent of net profits with increasing costs and could well care for this as one of their increased items of operation. To some of our members it may be just an added drop to their whole ocean of financial woes. However we cannot let our society suffer any material relapse from its present financial integrity.

In this connection it may be well to note some immediate effects upon our policies.

It has been the opinion of some of our wisest counselors that added interest and zest in our meetings could best be obtained through limitation in presentation of long papers, however valuable they might be in themselves, by printing in advance proceedings and presenting in convention not more than a synopsis, thus allowing for more interesting discussion from the floor. Endeavor has been made to carry out this idea at this convention. However, it has been found that the large increase in the cost of printing our advance proceedings has made it necessary to reduce such to some extent.

It has been, and now is, the policy of your President to have matters of interest presented to your sessions in such condensed form as to allow fair discussion. To those who are so kind as to present papers and reports it will be apparent that the omission in reading of tabulations of figures soon forgotten or of minor details may well lead to time saved and devoted to instructive discussion.

The President herewith announces and wishes it distinctly understood that the privileges of the floor in addressing the convention are extended to all associate members unless specific objection be made thereto or the privilege be mis-used, of which he has no fear.

Those who design and those who construct have a common desire; to provide that which is best suited to its particular use. The associates develop their articles or materials so as to best meet a particular end or need, and such requires high skill and industry.

The active member must acquaint himself with the particular needs to be met and then make unbiased choice of such as will best meet the requirements. That these two phases may be brought in harmony for the common good is a fundamental object of this society. The field is so broad that no one member may cover it in full. The only practical way is thru our committees, each especially qualified in its lines and the decisions of which must be our guide rather than the chance decision of those less well informed after desultory debate in open convention. The Committee must be the wide-open forum and its decision embody the wisdom of all for our guidance.

A fair view of our mutual relations can leave no honest differences and a broad view of our combined obligations to the municipal public can but lead this society into even broader fields of usefulness, to our common advantage.

PRESIDENT NORTON: Next on the program is the report of the Executive Committee to be read by the Secretary.

REPORT OF THE EXECUTIVE COMMITTEE

At the preliminary meeting of the Executive Committee held Monday evening, Oct. 11, the financial situation shown in the Secretary's report was thoroly discussed and referred to a special committee consisting of Messrs. Tillson, Reimer and Brown, and it was voted to give the President, Secretary and Treasurer authority to sell the Liberty Bonds in the possession of the Treasurer to meet, as nearly as possible, the existing deficit.

The committee made a report at the morning session of the Executive Committee, Oct. 11, in which it recommends:—

1. That the discussions be edited to make them as brief as possible.
2. That the Advance Papers be not published.
3. That each author be requested as far as possible to supply his own cuts for illustrations.
4. That the business proceedings be abstracted as much as possible.
5. That the geographical list of members be omitted.
6. That the detailed Index be omitted.
7. That the Proceedings be bound in cloth.
8. That the dues be increased 50 per cent. An amendment to the Constitution was offered to give effect to this recommendation.

The proposition to cooperate with the American Engineering Standards Committee was referred to the President with power to appoint the necessary committees to make cooperation effective as may be required from time to time.

Various communications from Societies regarding cooperation were presented and referred to the incoming President with power to appoint such representatives and committees as he might deem best in such cases as seemed proper to him to consider the proposed cooperation.

Certain proposed amendments to the Constitution were considered in considerable detail and on motion it was decided to refer to the Society an amendment to Art. III, Sec. 1, increasing dues fifty percent and such amendment was prepared and signed by the members of the Executive Committee for presentation to the Convention in regular order. Mr. E. A. Fisher was appointed a committee to prepare an amendment to Article IV. Sec. 4, revising the list of committees as outlined in the discussion, for presentation to the convention.

A resolution requesting the regular continuance of statistics of financial operations of cities by the U. S. Bureau of the Census was discussed and referred to the Convention for its action.

The President was authorized to appoint two associate or affiliated members from officers or individuals specially expert, to serve with the regular committees of five active members each to aid the committees but to be without vote or power to change the recommendations made by the committees.

All acts of the Executive Committee on Monday evening were approved and adopted. Several invitations for the 1921 Convention were recorded and referred to the Committee on place of meeting when appointed.

The following additions to membership were made. A list of members delinquent in dues was presented and the Secretary was instructed to drop those who did not make payment before the Proceedings of the Convention were published. (The list of those so dropped follows the list of new members.)

CHANGES IN MEMBERSHIP

NEW MEMBERS

ACTIVE

Maurice Z. Bair	Little Rock, Ark.
H. E. Barnes	Shreveport, La.
Harry F. Bascom	Allentown, Pa.
Guy Brown	St. Louis, Mo.
L. R. Bowen	St. Louis, Mo.
W. W. Burden	St. Louis, Mo.
A. M. Buswell	Urbana, Ill.
C. S. Butts	St. Louis, Mo.
Alden Chase	St. Louis, Mo.
Leland Chivvis	St. Louis, Mo.
E. L. Christopher	St. Louis, Mo.
W. E. Crecelius	St. Louis, Mo.
F. T. Cutts	St. Louis, Mo.

C. M. Daly	St. Louis, Mo.
Charles E. DeLeuw	Chicago, Ill.
R. C. Gans	St. Louis, Mo.
D. P. Gaymon	Pueblo, Colo.
E. F. Harper	East St. Louis, Ill.
O. F. Harting	St. Louis, Mo.
C. L. Hawkins	St. Louis, Mo.
W. A. Heimbuecher	University City, Mo.
James A. Hooke	St. Louis, Mo.
H. S. Jaudon	Elberton, Ga.
Maurice L. Jones	Benton Harbor, Mich.
H. W. Kiel,	St. Louis, Mo.
E. R. Kinsey	St. Louis, Mo.
Ralph G. Lingley	Worcester, Mass.
James Malone	Sioux City, Iowa
J. N. McKelvey	St. Louis, Mo.
Julian Montgomery	Wichita Falls, Texas
Arthur L. O'Leary	East St. Louis, Ill.
Leo Osthaus	St. Louis, Mo.
Ernst Paffrath	St. Louis, Mo.
F. W. Pape	St. Louis ,Mo.
Julius Pitzman	St. Louis, Mo.
W. E. Rolfe	St. Louis, Mo.
W. A. Ruch	Allentown, Pa.
John Schmoll	St. Louis, Mo.
J. M. Slater	St. Louis, Mo.
E. F. Sobolewski	St. Louis, Mo.
Jos. Stiffelman	St. Louis, Mo.
Wm. Stoecker	St. Louis, Mo.
C. M. Talbert	St. Louis, Mo.
Kurt Toensfeldt	St. Louis, Mo.
Ralph Toensfeldt	St. Louis, Mo.
Edward E. Wall	St. Louis, Mo.
E. D. Williams	St. Louis, Mo.

AFFILIATED

Chas. H. Diel	St. Louis, Mo.
J. T. Dodds	St. Louis, Mo.
Edw. Hidden	St. Louis, Mo.
Herman Spoehrer	St. Louis, Mo.
F. E. Turin	St. Louis, Mo.
J. D. Von Maur	St. Louis, Mo.

ASSOCIATE

The Dorr Co., J. S. Sherman, Representative	New York City
The Holt Mfg. Co., H. B. Baker, Representative	Peoria, Ill.
Rodman Wiley, Representative Kentucky Rock Asphalt Co.	Louisville, Ky.
G. O. White, Representative Sinclair Refining Co.,	Memphis, Tenn.

LOSSES OF MEMBERSHIP

RESIGNATIONS

ACTIVE

F. M. Miner	Boston, Mass.
Joseph Strachan	Brooklyn, N. Y.

ASSOCIATE

Walter C. Parmley	New York City

DROPPED FOR NON-PAYMENT

J. N. Ambler	Winston, N. C.
F. J. Anderson	South Bend, Ind.
C. H. Barrett	Gloucester, Mass.
E. Bourleau	Chicopee, Mass.
G. C. Brehm	Marlboro, Mass.
G. H. Chase	Fitchburg, Mass.
O. D. Chrisman	Springfield, Mo.
P. P. Condon	Watertown, Mass.
E. H. Coward	Pittston, Pa.
G. C. Cummin	New York City
C. O. Davis	Milwaukee, Wis.
E. A. Daylor	Coatesville, Pa.
H. Devlin	Bronx Boro, N. Y.
P. Durkin	Danbury, Conn.
H. A. Evers	Cranston, R. I.
H. W. Heilman	Newark, N. J.
W. R. Hillyer	Port Richmond, N. Y.
J. B. Hodgdon	Joplin, Mo.
I. S. Horton	Reading, Pa.
R. C. Huston	Memphis, Tenn.
F. W. Jennings	Columbus, O.
A. P. Kappele	Hamilton, Ont.
W. E. Kennedy	Waterbury, Conn.
N. A. Knapp	Greenwich, Conn.
J. Kraus	Flushing, N. Y.
G. E. MacDonald	Gloucester, Mass.
K. I. Marchant	Gloucester, Mass.
R. McCandless	New Rochelle, N. Y.
J. J. McCarthy	Brooklyn, N. Y.
T. McCoubry	Chicopee, Mass.
S. K. McCrary	Atchison, Kan.
P. F. McMahon	Brockton, Mass.
J. V. Meigs	Montclair, N. J.
W. B. Moorehouse	Tarrytown, N. Y.
L. T. Morgan	Brunswick, Ga.
C. Schmieder	New York City
F. F. Simons	Carteret, N. J.
F. E. Smith	Rockport, Mass.
H. A. Snow	Brockton, Mass.
E. E. Spetman	Council Bluffs, Ia.

A. Swan	Trenton, N. J.
S. F. Upington	New Rochelle, N. Y.
H. S. Warman	Boonton, N. J.
F. V. Waterman	E. Providence, R. I.
H. H. White	Muskogee, Okla.
W. T. Wooley	Schenectady, N. Y.
E. J. Wulff	Tarrytown, N. Y.

PRESIDENT NORTON: The matters in this report of the Executive Committee will be brought up under the regular order of business. Next in order is the report of the Secretary.

REPORT OF THE SECRETARY

Charles Carroll Brown, Valparaiso, Ind.

The Secretary presents his report for the year ending October 1, 1920.

The following table gives the record of changes in membership for the year beginning October 1, 1919, and ending October 1, 1920:

	Sept. 30, 1919	Admitted During the Year	Lost During the Year	Membership Sept. 30, 1920
ACTIVE	426	78	47	457
AFFILIATED	22	7	5	24
ASSOCIATE	96	45	11	130
TOTALS	544	130	63	611

Following are the changes in personnel since the publication of the list on page 703 of the Proceedings for 1919:

NEW MEMBERS

ACTIVE

J. W. Battershill	E. Kildonan, Man.
J. S. Buzby	Burlington, N. J.
F. H. Craven	Philadelphia, Pa.
G. B. Ford	New York City
Lawrence Griffith	Yonkers, N. Y.
H. R. F. Helland	Waxahachie, Tex.
R. B. Howell	Omaha, Neb.
Bancroft Kress	Danville, Va.
R. K. Linville	Charleston, W. Va.
J. A. McElroy	Bridgeport, Conn.
C. F. Mebus	Philadelphia, Pa.
M. D. Pace	Troy, Ala.
Rudolph Schweizer, Jr.	Ridgefield Park, N. J.
William Storrie	Toronto, Ont.
H. R. Van Duyne	Newark, N. J.
Herman Warden	Pasco, Wash.
G. S. Webster	Philadelphia, Pa.
J. C. Winston	Philadelphia, Pa.

Affiliated

W. L. Gay	Chattanooga, Tenn.
R. W. Parlin	New York City

Associate

W. D. Craven, Jr., Rep. Standard Oil Co., of N. Y.	New York City
New Orleans Refining Co., C. B. Filbert, Rep.	New Orleans, La.
S. G. Reynolds, Additional Rep. Birmingham Slag Co.	Atlanta, Ga.

Losses in Membership

Municipal Delegates Not Re-Appointed

Chester E. Albright	Philadelphia, Pa.
Geo. E. Datesman	Philadelphia, Pa.
J. M. Kistler	Minneapolis, Minn.

Resigned Active

C. E. Estler	Boonton, N. J.
A. J. Provost, Jr.	New York City

Deceased Active

Wm. M. Brown	Newark, N. J.
E. E. Goff	Cranston, R. I.
S. C. Thompson	New York City
J. C. Winston	Philadelphia, Pa.

Mail Returned Undelivered

Active

John E. Ballinger	Hampton Roads, Va.
W. H. Flood	Chicago, Ill.
J. W. Ogier	Baltimore, Md.

Associate

K. Lydecker	New York City

Representatives of Associate Members not Re-Appointed

E. B. Abbett	Louisville, Ky.
E. F. Fitzpatrick	Chicago, Ill.
W. A. McIntyre, Atlas Portland Cement Co.	New York City
D. H. Wyatt	Columbus, O.
A. T. Rhodes	Worcester, Mass.

The following table shows the monthly receipts during the year, classified as to source, and the monthly remittances to the Treasurer.

Month 1919	MEMBERSHIP DUES Active	Affiliated	Associate	Proc. Sold	Spec. Sold	Advts.	Misc.	Remitted to Treas.	Date
Oct.-Nov.	462.50	17.50	230.00	16.73	2.75	30.00	....	759.48	12-11-1919
Dec.-Jan. 1920	115.00	.....	......	43.00	3.00	......	2.06	163.06	2-6-1920
Feb.	485.00	35.00	490.80	14.00	.....	......	....	1024.80	2-28-1920
Mar.	186.50	25.00	87.50	22.00	11.99	......	....	332.99	3-30-1920
April	93.00	.....	95.00	......	4.13	......	....	192.13	4-30-1920
May	165.00	12.50	40.00	13.00	3.00	......	0.50	234.00	6- 1-1920
June	60.00	2.50	10.00	27.00	0.75	170.76	0.55	271.56	6-30-1920
July	42.50	.....	......	62.00	2.75	239.30	....	346.55	8- 7-1920
Aug.-Sept.	155.00	5.00	20.00	54.50	.....	212.75	1.00	448.25	9-26-1920
Totals	1764.50	97.50	973.30	252.23	28.37	652.81	4.11	3772.82	

To the above report of receipts should be added $31.87 interest on Liberty Bonds, reported by the Treasurer as collected and deposited to the Society's account, making a total of receipts for the year of $3804.69.

The vouchers for expenditures and checks drawn therefor are listed by the Treasurer in his report. The items under these totals have been classified by the Secretary and show the following classified expenditures.

OFFICE AND MISCELLANEOUS

Printing and Stationery	$128.75	
Telegrams and Exchange	15.71	
Postage, Express and Freight	180.47	
Clerical	600.00	
Treasurer's Expense	10.50	
Office Supplies	15.15	950.58
Proceedings		2496.31
Specifications		56.50
Convention Expense		504.41
		$4007.80

It will be noted that the increase in receipts over the previous year is nearly $500.00 and about $1000.00 more than in 1918. Every item but specifications sold and miscellaneous receipts shows an increase, the most notable increase being in Associate Membership dues and in advertisements, the latter being the largest in our history.

Most of the items of expense are less than last year, those for printing and stationery, specifications, and convention expense, being materially less than in previous years. However, the cost of printing and distributing the Proceedings, including the advance papers, was much greater than the previous year. This was caused in part by the increase in size of the volume for 1919 over that for 1918, and by the large booklet of Advance Papers of the 1919 Convention, but the increase in cost of printing is responsible for a very large part of the increase. The whole cost of the Proceedings is not shown in the report as we still owe the printer $1330. In addition the Secretary's salary, $300, has not been paid during the past year.

The following table analyzes the expenses of the Society since 1916 and (omitting 1917 because we held no Convention that year and expenses were consequently low) shows a progressive increase in cost of printing each year.

The first line shows the total expenditures of the year, those for 1919 being increased by $1630.00, the amount of unpaid bills.

The second line shows the number of members at date of same report.

The third line shows the total expense per member.

The fourth line shows the general expense of operating the Society, obtained by subtracting the cost of printing and distributing Proceedings and Advance Papers from the total cost of operation.

The fifth line shows the general expense per member for each year.

The sixth line shows the cost of printing and distributing Advance Papers.

The seventh line shows the cost of printing and distributing Advance Papers per member.

It is evident from these figures that the Society could not live in ordinary times if it had no source of income other than dues of members. The succeeding lines in the table are given to show what the income comes from.

The eighth line shows the total income from dues each year.

The ninth line shows the income from dues per member per year. It is always less than the nominal annual dues because the list always contains a number of names of members who have not paid their dues for a year or more.

The tenth line shows the other income of the Society from Proceedings and Specifications sold, from advertisements and a little from other sources.

The eleventh line shows the amount of this income per member.

The twelfth line shows the total income per member.

Comparison of this line with that showing total expenditures per member shows that the Society has been reducing its balance in the treasury every year except 1917, when expenses were low enough to produce a surplus even if dues were not so well paid up that year. This surplus has carried the Society until this year, when, as shown farther down in the table, the high cost of printing has increased so much as to wipe it out as well as the increased income from nearly all sources and has produced a serious deficit in addition.

The thirteenth line shows the number of pages in the Proceedings of each year.

The fourteenth line shows the cost per page of Proceedings each year, including Advance Papers.

The fifteenth line shows the cost per copy of Proceedings each year, the number of copies printed being uniformly 750 per year.

These three lines show to some extent the relative cost of printing and distributing Advance Papers and Proceedings. Always omitting 1917 because conditions are so different for that year, the rapid increase in cost each year is shown. The actual cost per copy is also seen.

The volume of Advance Papers for 1919 was larger than usual and added $2.10 to the cost per page of the Proceedings alone and $2.03 to the cost per copy. It is evident, therefore, that the charge of $2.00 made to libraries on vote of the Society must be increased if the Society is to come out even on them. Considering the cost of mailing, and the cost of Proceedings only, the price should be made $4.00 and if the total cost of Advance Papers and Proceedings is considered the price should be made $5.00.

		1916	1917	1918	1919
1.	Total Expenditures	$4461.99	$2061.39	$3848.74	$5637.80
2.	Number of members	606	543	544	612
3.	Total expense per member	7.36	3.80	7.07	9.21
4.	General Expense	2474.69	1311.28	2185.54	1811.49
5.	General Expense per member	4.08	2.42	4.02	2.96
6.	Cost of Proceedings and Advance Papers	1987.30	750.11	1662.46	3826.31
7.	Cost of Proceedings and Adv. Papers per member	3.28	1.38	3.05	6.25
8.	Income from dues	2860.10	2120.20	2482.00	2835.30
9.	Income from dues per member	4.72	3.90	4.56	4.63
10.	Other income	1536.87	629.26	804.07	937.52
11.	Other income per member	2.53	1.16	1.48	1.53
12.	Total income per member	7.25	5.06	6.04	6.16
13.	Number of pages of Proceedings	740	240	448	726
14.	Cost per page	2.69	4.38	3.71	5.27
15.	Cost per copy (750 copies printed) including Advance Papers	2.65	1.40	2.22	5.10

The following comparisons of the prices paid for 1919 Proceedings and those bid for the 1920 Proceedings will show what our prospects are for the coming year.

The standard 10-point page of this year cost $2.15 for type-setting, paper and press work complete. The same will cost $3.54 for 1920. The large increase in membership expected at this Convention will require an increase in the number of copies printed. If we sell our Liberty Bonds at this time we will lose 10 or 12 per cent on them, but the deficit must be made up in some way. However, the Advance Papers cost only $175.00 this year, including postage.

If we compute the cost of the 1920 Proceedings on the basis that they are exactly like the 1919 volume, their cost will be about $3300.00. Assuming that the cost of additional copies beyond 750 is met by the dues of the new members requiring them, the deficit for next year will probably be about the same as for this year, $1630.00. An increase in dues of $2.00 will not cover this deficit. An increase of $3.00 will cover it and allow some balance to meet the existing deficit. By setting the Proceedings "solid" as shown in the Advance Papers, instead of "leaded" as shown in the Proceedings for 1919, a saving of about 20 per cent in size of the volume can be made. Also the papers are not so long, nor are the illustrations as numerous. It is probable, therefore, that enough can be saved without reducing the present service to members to meet the whole deficit. In that case, the dues can be reduced again for 1922.

On motion the report was referred to the Finance Committee.

PRESIDENT NORTON: The next is the Treasurer's Report.

REPORT OF THE TREASURER

Fred J. Cellarius, Dayton, Ohio

DISBURSEMENTS

1919			
Nov.	30	Hauser Printing Co., Printing Conv. Program	$ 200.00
Nov.	30	Wade & Wise, Printing, Office Exp.	24.00
Nov.	30	Franklin Press, Payment on Advance Papers for Conv.	500.00
Nov.	30	U. S. Photo Engraving Co., Cuts for Proceedings	150.00
Nov.	30	C. C. Brown, Office exp., Oct. & Nov. 1919	131.82
1920			
Jan.	31	Southern Surety Co., Premium on Treasurer's Bond	7.50
Jan.	31	Hauser Printing Co., Printing Programs 1919 Conv.	142.42
Feb.	28	Franklin Press, Printing Advance Papers 1919 Conv	320.94
Feb.	28	U. S. Photo Engraving Co., Making Cuts for 1919	375.19
Feb.	28	C. C. Brown, Sect., Conv. Exp.	93.92
Feb.	28	C. C. Brown, Sect., Office Exp. 3 months	203.36
Mar.	31	Central Law Reporting Co., Stenographic Report of N. O. Con.	150.00
Mar.	31	Wade & Wise Co. Printing & Stationery, Office & Committee Expenses	50.50
Mar.	31	U. S. Photo Engraving Co. Cuts for Proceedings	7.58
Mar.	31	C. C. Brown, Office Exp. March, 1920	63.47
Apr.	30	Edgar Walsh & Co., Printing & Stationery, Con. Committee Ex.	11.50
Apr.	30	C. C. Brown, Sect., Office Expense April 1920	59.50
May	29	Wade & Wise Co., Printing, Stationery, Committee Exp.	37.75
May	29	Franklin Press, Printing Proceedings	5.50
May	29	Franklin Press, Printing Proceedings 1919 1st Installment	350.00
May	29	C. C. Brown Sect., Office Exp. 1920	56.52
June	30	Wade & Wise Co., Office Stationery, Printing Letter Heads	11.50
June	30	Harcol Film Co., Conv. Exp.	21.00
June	30	Franklin Press, Printing	56.50
June	30	Franklin Press, Printing Proceedings 2nd Instalment	80.00
June	30	C. C. Brown, Sect., Conv. Exp., Trip to St. Louis	27.99
June	30	C. C. Brown, Sect., Office Expense	76.00
July	31	Wade & Wise Co., Proceedings	5.00
July	31	Dayton Savings and Trust Co., Safety Deposit Box Rent	3.00
July	31	Franklin Press, 3rd Instalment on Printing Proceedings	270.00
July	31	C. C. Brown Sect., Office Exp. July	70.44
Sept.	27	Wade & Wise, Printing Letters to Members, Office Exp	5.00
Sept.	27	U. S. Photo Engraving Co. Cuts for Advertisements	16.31
Sept.	27	Franklin Press, Printing 1919 Proceedings, 4th Instalment	273.37
Sept.	27	C. C. Brown, Sect., Office Exp. Aug. & Sept. 1920	150.22
		Total Disbursements	$4007.80

RECEIPTS

	Cash on hand as per last report	$ 252.24
1920		
Jan. 3	C. C. Brown	759.48
Feb. 14	C. C. Brown	163.06
Feb. 28	C. C. Brown	1024.80
Apr. 6	C. C. Brown	332.99
May 10	C. C. Brown	192.13
June 3	C. C. Brown	234.00
July 6	C. C. Brown	271.56
Aug. 12	C. C. Brown	346.55
Oct. 2	C. C. Brown	448.25
Oct. 5	Liberty Bond Interest 6 months	31.87
	Total Receipts	$4056.93
	Total Disbursements	4007.80
	Balance, Cash on Hand	$ 49.13

I have the honor to report that I have in my possession Liberty Bonds as follows:

No. 15955—Liberty Bond, third issue	$ 500.00
No. 472628—Liberty Bond, third issue	1000.00

Respectfully submitted
F. J. Cellarius

On motion the report was referred to the Finance Committee.

PRESIDENT NORTON: The report of the Finance Committee will be presented later. Next is the selection of our Committee on Nominations.

Nominations were made from the floor as follows: Messrs. Giddings, Christ, Sprague, Rudolph and Howell, and the committee as nominated was duly elected.

PRESIDENT NORTON: Next in order is the nomination of a Committee on Place of Meeting.

Nominations were made from the floor as follows: Messrs. Tillson, Hatton, Winston, Howell of Buffalo, Sammelman, and the committee as nominated was duly elected.

PRESIDENT NORTON: Next is the Committee on Resolutions.

Nominations were made from the floor as follows: Messrs. Compton, Reimer, Rankin, Davis of Richmond, Ind. and Kendrick. And the committee as nominated was duly elected.

PRESIDENT NORTON: Next is the introduction of proposed amendments to the Constitution and other new business. There have been two amendments presented, one relating to increase of dues fifty per cent, and the other proposing to increase two or three of the committees by making an overhead chairman, other members of the committee to be chairmen of sub-committees. As required by the Constitution, these have been presented, signed by ten members, and will be taken up on the third day of the Convention. The time will be announced. I suppose that will be the proper time to discuss these amendments, after you have had time to look them over. I think it would be well for the Secretary to have them posted where you can read them.

SECRETARY BROWN: We will have that done.

PRESIDENT NORTON: These two amendments will be brought up for discussion on Thursday. Are there other amendments to be presented? The constitution requires that the amendments must be signed by ten members. They must be presented on the first day of the Convention and considered on the third day.

Is there any unfinished business to be brought up at this time?

PRESIDENT NORTON: Now, gentlemen, that brings us down to the reports of the committees. The Secretary informs me that the report of the Committee on Public Markets has not been received.

Next is the report of Committee on Water Works and Water Supply by Mr. Sherrerd. No report has been received. Has any member a report from him?

DELEGATE: Mr. Sherrerd told me he was particularly anxious to get here. At the last minute other business prevented his coming. He also told me that he had not, up to that time, prepared any report.

PRESIDENT NORTON: Report of the Committee on Municipal Legislation and Finance. No report has been received.

Report of Committee on Street Cleaning, Refuse Disposal and Snow Removal. No report has been received.

Next is "Methods of Snow Disposal" by Mr. H. S. Richards, Maintenance and Repair Division, South Park Commissioners, Chicago, Ill.

In the absence of the author the paper was read by the secretary. It will be found on page 1 of this volume.

Adjournment followed.

Tuesday Afternoon, October 12, 1920

The meeting convened at two o'clock, President George H. Norton presiding.

PRESIDENT NORTON: In the matters presented in the report of the Executive Committee this morning was a request from the National Association of Comptrollers of the country, asking that this society join in requesting the United States Census Bureau to continue the publication of its statistics. As you know, the Census Bureau publishes such information from time to time, and they have made the announcement that they wish to postpone this for a year or two on account of the pressure of the 1920 census work. The President of this Association can give us some information on this subject, Mr. C. C. Pashby.

Mr. Pashby then presented a most interesting statement of the need of the publication of these statistics as helpful in intelligent considera-

tion of the financial matters of municipalities, and invited the Society to send a representative to the convention of his Association at Buffalo next June.

PRESIDENT NORTON: Mr. Pashby presented this matter in a very clear manner to the society. He has also furnished us with a set of resolutions presented this morning. The secretary will read the resolutions.

Whereas the Bureau of the Census in the Department of the Commerce at Washington has for many years collected and published the financial statistics of cities having a population in excess of 30,000, and

Whereas, by the reports of the last census more than fifty per cent of the population of the United States is found to be living within incorporated municipalities,

Whereas, at the present time the problems of properly financing municipalities so that the improvements necessary to health and comfort of this urban population may go forward are pressing for solution as never before, and

Whereas, this long line of reports compiled and published by this bureau of the Government is the only authentic source of information by which each city may compare its results with those of other places, and

Whereas on August 20, 1920, the Director of the Bureau of the Census announced that he had decided to omit the collection of these valuable statistics for the year 1919, i. e. the statistics which would have been collected early in the year 1920 under ordinary circumstances, and

Whereas the reasons assigned for the omission of this report are not sufficient in our judgment to warrant this contemplated break in this chain of information, therefore

Be it Resolved by the American Society for Municipal Improvements that it is the sense of this Society that said data should be collected and published even tho it is necessary that it should be a year late in coming out, and

Be it further resolved, That the Secretary be and is hereby instructed to transmit a copy of these resolutions to the Director of the Census and to the Secretary of Commerce.

Upon motion the resolutions were adopted.

PRESIDENT NORTON: The next is the Report of the Committee on Street Lighting, which is published in the Advance Papers, and will not be read unless you desire it at this time.

The report will be found on page 44.

The next matter before us is "Street Lighting in St. Louis" by Ralph Toensfeldt, Engineer Department of Public Utilities, St. Louis, Mo.

The paper was not furnished for publication. The discussion will be found on page 293.

PRESIDENT NORTON: If there is no further discussion,we will pass to the next paper, "The St. Louis Water Works, by F. T. Cutts, Assistant Water Commissioner, St. Louis, Mo.

The paper will be found on page 265.

PRESIDENT NORTON: Any discussion? If not, we will pass to the next paper, "The Making of Regional Surveys" by Thomas Adams, Town Planning Adviser, Commission of Conservation, Ottawa, Ontario, Canada.

I am sure we all regret the absence of Mr. Adams, well known in city planning work. He was unable to be with us, and in his absence, I doubt if it would be well to have discussion at this time. If you have discussion, it might be taken up at our city planning session later on.

The paper will be found on page 55.

PRESIDENT NORTON: The next matter is the report of the Committee on Parks and Parkways, John M. Rice, Chairman.

The report will be found on page 51.

PRESIDENT NORTON: Gentlemen, you have heard the instructive report of the chairman of this committee. As he has stated, the suggestion for the division into a series of committees on general city planning work was taken up by the Executive Committee and the recommendation given to you this morning, as an amendment to the Constitution, which will be taken up and voted upon on Thursday, will, I believe, dispose of that portion of the recommendations.

The chairman has made certain other recommendations which would be in the nature of establishing a policy for the future committee on this subject. Does the society wish to take any positive action on this matter, or refer it to the reorganized committee. What was your idea, Mr. Rice?

MR. RICE: Mr. President, I think there is no action necessary now, more in the line of suggestions, and if any person here takes exception to it, the proper time to take it up would be when considering the resolution.

PRESIDENT NORTON: This report will then be received and printed, and the Secretary will bring these recommendations to the attention of the new and enlarged committee if this amendment to the Constitution is adopted.

Next is the report of the Committee on Fire Prevention, Alcide Chausse, Chairman, of Montreal. This is printed in the Advanced Papers, and I believe it does not need discussion at the present time.

The report will be found on page 134.

The next on the program is the paper "Fire Prevention and Fire Fighting" by Clarence E. Ridley, City Engineer, Port Arthur, Texas. Mr. Ridley was not able to be present. The paper has been received and will be printed in the proceedings. The paper by Mr. Corson will be postponed to a later date.

Mr. Ridley's paper will be found on page 137.

The next paper is that on "Municipal Finance" by Louis Nolte, City Comptroller of St. Louis. Mr. Nolte is not able to be present, but the paper will be read by Mr. Cunningham.

The paper will be found on page 140.

There being no discussion of the paper the Convention adjourned until Wednesday morning.

Wednesday Morning, October 13, 1920

The meeting convened at 9:30 a. m., President George H. Norton presiding.

PRESIDENT NORTON: The program this morning is mostly on sewerage and sanitation and is headed by the report of the Committee on Sewerage and Sanitation, F. A. Dallyn, Chairman, Provincial Sanitary Engineer, Toronto, Ontario. Mr. Dallyn has done a great deal of excellent work in this Society, but unfortunately, he was taken ill the latter part of last week, and is unable to be present. We expected his report, but probably his sudden illness has unsettled his arrangements so it will be impossible to present that report at this time.

The next matter is "The Work of the Sanitary District of Chicago, Past, Present and Future, from a Sanitary Standpoint" by Mr. Langdon Pearse, Sanitary Engineer, Chicago, Ill.

A MEMBER: In the experimental plant for straight domestic sewage I notice the tank was only 16 feet deep. I am wondering if the results on the sludge from that tank were different from those ordinarily found in deeper tanks.

MR. PEARSE: We got a very good sludge because we had a liberal allowance for the sludge chamber. We have not had any trouble in our tanks 16 feet deep.

The paper was not supplied for publication.

PRESIDENT NORTON: In his address yesterday morning, Vice President Compton outlined a little of the early history of the society, mentioning the fact that during its life we had had one President who had served two terms, our First President, M. J. Murphy of this City, President in 1894 and 1895. The following article is in this morning's paper.

"The funeral of Michael J. Murphy, 87 years old, who died at two o'clock Monday afternoon from pneumonia, will be held at nine o'clock this morning from St. Francis Xavier's Church. During his life time he served as Harbor and Wharf Commissioner, Street Commissioner, president of the Board of Education and president of the Mullanphy Board. He was born in Herkimer,

N. Y. and came to St. Louis at the age of fourteen years. Before the Civil war he was engaged in the furnishing goods business on Main street, a member of the firm of Gill & Murphy. After the war the business was moved to Washington avenue, where it was known as M. J. Murphy & Co. He retired in 1870 from business and engaged in practicing law. Since that time he has held numerous public offices."

Members, it seems to me our first President was a man of some foresight, as shown in organizing this society. If you will, permit the suggestion of the President that the Convention arise and stand a moment in memory of our first President.

The Convention arose and stood with bowed heads.

PRESIDENT NORTON: The next matter on the program is "The St. Louis Sewer System" by W. W. Horner, Chief Engineer Paving and Sewerage, St. Louis, Mo.

The paper and discussion thereon will be found on page 12.

"The Present Status of the Activated Sludge Process" by Edward Bartow, Head of Department of Chemistry, Iowa State University, Iowa City, Iowa, is next.

The paper and discussion thereon will be found on page 280.

PRESIDENT NORTON: The next on our program is "The Disposal of Trade Wastes" by Mr. Robert Spurr Weston, Consulting Engineer, Boston, Mass. As Mr. Weston is not here the paper will be passed.

The paper will be found on page 33.

The next is "The Miles-Acid Process on Tannery Sewage Waste" by E. S. Dorr, Engineer in Charge of Special Work, Sewer Department, Boston, Mass. The Secretary will read the paper.

The paper will be found on page 42.

PRESIDENT NORTON: Is there discussion upon this paper? If not, the next on the program is "Ten Years' Operation of Municipal Garbage Reduction Works" by Walter B. Bee, Superintendent of Municipal Reduction Works, Columbus, Ohio. I understand Mr. Bee was not able to be present and the matter will be passed.

The paper will be found on page 10.

The next is not shown on the printed program. "Sewage Treatment at Bridgeport, Conn." by Jas. A. McElroy, City Engineer, Bridgeport, Conn. This paper, because of the lateness of the hour, will not be read, except by title. The formal session is now adjourned.

The paper will be found on page 19.

Wednesday Evening, October 13, 1920

The meeting convened at eight o'clock, President George H. Norton, presiding.

PRESIDENT NORTON: The first matter before the society this evening is the election of officers for the ensuing year. The Committee on Nominations will make their report.

Your Committee on Nomination of Officers for the ensuing year recommend for President, Mr. R. Keith Compton of Baltimore, Md., First Vice-President, Mr. E. S. Rankin of Newark, N. J., Second Vice President, Mr. W. W. Horner of St. Louis, Mo., Third Vice President, Mr. E. R. Dutton of Minneapolis, Minn., Secretary, Mr. Charles Carroll Brown of Valparaiso, Ind., Treasurer, Mr. Herman H. Smith of Brooklyn, N. Y. Finance Committee: Mr. Frederick A. Dallyn of Toronto, Canada, Mr. C. Arthur Poole of Rochester, N. Y., Mr. Simon Cameron Corson of Norristown, Pa.

FRED GIDDINGS
E. H. CHRIST
N. S. SPRAGUE
C. A. RUDOLPH
WILLIAM A. HOWELL
Committee

MR. GIDDINGS: I move the adoption of the report.

The motion was duly seconded.

PRESIDENT NORTON: Gentlemen, the Committee have made their report. The Chairman moves the adoption of the report. The motion has been seconded. Are there amendments to this motion? (*None presented.*) If there are no further nominations, the matter is before the house.

MR. TILLSON: I move the Secretary be instructed to cast one ballot for the election of officers as recommended by the Committee.

The motion was duly seconded, put and carried.

PRESIDENT NORTON: The second matter is the selection of place of next meeting.

Your committee which was appointed for the purpose of recommending a place of meeting for the 1921 Convention would report that invitations have been received from Baltimore, Cleveland, Detroit, San Francisco, Chicago and New York.

The invitations from Baltimore and Cleveland however are the only ones coming directly from City officials.

After giving the matter careful consideration the committee has decided that the best interests of the society will be conserved by the selection of Baltimore and it is therefore recommended that the next convention of this society be held in Baltimore, Md.

All of which is respectfully submitted.

GEO. W. TILLSON
C. A. WINSTON
T. CHALKLEY HATTON
S. SAMMELMAN
C. L. HOWELL
Committee

MR. TILLSON: I move the adoption of this report.

The motion was duly seconded, put and carried.

PRESIDENT NORTON: The choice for the convention is Baltimore.

The first article on the regular program this evening is the report of the Committee on City Planning. Mr. Bartholomew is Chairman.

MR. BARTHOLOMEW: Mr. President, and gentlemen, we have no definite committee report this year. We thought if we could have a series of different papers and different subjects on city planning, that that might prove more interesting and give us more valuable information about the current work of city planning than the committee report. Consequently, Mr. Sprague, Mr. Lewis and myself have obtained different papers and those are on the program and will be read, so we won't attempt to take up your time with a committee report.

PRESIDENT NORTON: The next paper is "The St. Louis City Plan" by Mr. E. R. Kinsey, President of Board of Public Service, St. Louis, Mo.

The paper will be found on page 60.

PRESIDENT NORTON: Are there any questions to be asked or discussion upon this paper? If not, the next matter upon our program is "The Zoning Plan Recently Adopted for Washington, D. C." by Harland Bartholomew, Engineer City Plan Commission St. Louis, Mo.

The paper will be found on page 64.

PRESIDENT NORTON: Any discusssion? If not, the next paper upon the program is "Pittsburg Problems in City Planning, Due to Rugged Topography" by Mr. N. S. Sprague, Chief Engineer Bureau of Engineering, Pittsburg, Pa.

An abstract of the paper will be found on page 73.

PRESIDENT NORTON: Is there any discussion upon Mr. Sprague's paper? If not, we will pass to the next paper, "Transportation and the City Plan" by Mr. Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment, New York, N. Y. Unfortunately Mr. Lewis was unable to be here. Mr. Bartholomew has the paper which only came in today. Mr. Bartholomew will read the paper.

The paper will be found on page 74.

PRESIDENT NORTON: As Mr. Lewis is not with us, we will pass the discussion on this paper at the present time. As Mr. Ford is obliged to leave town at an early time, we will take up his paper next. "Suggestions from French Practice in Municipal Improvements" by Mr. George B. Ford, Director City Planning Department, Technical Advisory Corporation, New York City.

The paper will be found on page 82.

PRESIDENT NORTON: As Mr. Ford is obliged to leave there will be no discussion on this interesting talk. The next paper is "The Construction of Municipal Bridges and Buildings in St. Louis" by L. R. Bowen, Engineer of Bridges and Buildings.

The paper will be found on page 88.

PRESIDENT NORTON: Owing to the lateness of the hour, the next paper, "The Relation of Zoning to the Work of the City Engineer" by Vice President E. S. Rankin, Engineer Bureau of Sewers, Newark, N. J., will be read by title only at this time. We will take that up later. This concludes the regular program for the evening.

Thursday Morning, October 14, 1920

The meeting convened at 9:30 A. M., President George H. Norton, presiding.

PRESIDENT NORTON: At the close of last evening's program, we were unable to reach the paper of Mr. Rankin, "The Relation of Zoning to the Work of the City Engineer."

The paper will be found on page 70.

PRESIDENT NORTON: You have heard the paper, any discussion? We will take up the next paper, "Producing and Refining of Asphalt" by Mr. Herbert Spencer, Engineer Standard Oil Company of New Jersey, New York City.

The paper and discussion thereon will be found on page 157.

PRESIDENT NORTON: The next paper on the program is "Asphaltic Pavement Construction on Illinois State Highway and Chicago Boulevard Link" by John B. Hittell, District Engineer, The Asphalt Association, Chicago, Ill.

The paper will be found on page 189.

PRESIDENT NORTON: Gentlemen, any discussion or questions upon the interesting paper? There being none, we will now take up the first number on our program, the report of the Committee on Street Paving, William A. Howell, Chairman, Engineer in Charge of Bureau of Streets, Newark, N. J.

The report will be found on page 144.

PRESIDENT NORTON: The next paper is "The Elimination of Unnecessary Testing from Asphalt Specifications" by R. R. Barrett, Engineer, The Texas Company, New York City.

The paper will be found on page 172.

PRESIDENT NORTON: Are there any questions or discussion upon this paper? If not, the next is "Asphalt Block Pavements" by P. L. Thompson, Hastings Pavement Company, New York. This is one of the few papers we were able to print in the Advance Papers, and I will ask that he be as brief as possible in abstracting his paper inasmuch as it is before us.

The paper will be found on page 201.

PRESIDENT NORTON: You have heard the paper, any questions or discussion? If not, the next article upon the program is "The Present Status of Macadam Base for Bituminous Pavements" by Julius Adler, Technical Engineer, the Atlantic Refining Company, Philadelphia, Pa. This paper has been abstracted in the Advance Papers, and Mr. Adler is not here. We have a gentleman here who would like to discuss this paper, and I would ask that he be as brief as possible in his discussion to give a chance for more discussion.

The paper and discussion thereon will be found on page 177.

PRESIDENT NORTON: The next paper is "Wood Block Paving" by Hermann Von Schrenk, Consulting Engineer, St. Louis, Mo.

The paper and discussion thereon will be found on page 227.

PRESIDENT NORTON: If there is no further discussion, the meeting will stand adjourned.

Thursday Afternoon, October 14, 1920

The meeting convened at two o'clock, President George H. Norton presiding.

PRESIDENT NORTON: As we did not complete the morning's work, we will continue. The first thing this afternoon is "Concrete for Municipal Paving" by Col. H. C. Boyden, The Portland Cement Association, Chicago, Ill.

The paper will be found on page 240.

PRESIDENT NORTON: Any discussion upon the paper, or questions? We will take up the Specifications Committees' reports so far as they are ready, and then we will go back to the unfinished portion of the program.

The first matter is the report of the Committee on Sheet Asphalt Pavements, Col. R. Keith Compton, Chairman. This has been presented in the Advance Papers with the proposed amendments. The specifications presented to the Society may be amended in minor details during the convention, having been previously published.

REPORT OF COMMITTEE ON SPECIFICATIONS FOR SHEET ASPHALT PAVING

The Committee on Specifications for Sheet Asphalt Paving recommended the following changes in the existing Standard Specifications, the references being to the edition of these specifications adopted October 3, 1918:

I. Page 4, 2d paragraph last line: Change 25 (penetration) to *33*.

II. Page 5, small table: Change 35 (% passing 10-mesh) to *30*.

III. Page 6, table at top of page: Cut out table and change to read:

Passing 200-mesh........................0 to 5%
Total passing 80-mesh and retained on 200-mesh ....20 to 40%
Total passing 10-mesh and retained on 40-mesh ....12 to 45%

IV. Page 8. Paragraph 10, b. Change from 30 to 55 for heavy traffic streets and 55 to 85 for light traffic to *25*, *45*, *45*, and *70*, respectively. Insert new sentence: "*The penetration shall be determined by the engineer within the limits indicated above and shall include a tolerance of ten (10) per cent either way of the penetration set for the particular street.*

V. Page 9, First line: Add *by weight* after the word "proportions."

VI. Page 9, 8th line of Paragraph 8: For "concrete" read *prepared foundation.*

VII. Page 9, 16th, 17th and 18th lines, omit "and not more than . . . at any one spot" and insert period after inches and add the sentences: *Low spots or depressions in the foundation more than one inch below the grade thereof shall be filled and brought to grade with binder mixture and compressed prior to the spreading of the binder course. Compression must be effected by a roller if the depressions are of a sufficient area, otherwise tampers may be employed.*

VIII. Page 10, 2d paragraph, 2d line: For "concrete" read *foundation.*

IX. Page 10, section 13, 3d line: For "thirty-five (35)" read *twenty-eight* (*28*).

X. Replace present Section 15, pp. 10-12 to read as follows:

15. *Laying*—The surface mixture prepared in the manner above described shall be brought to the work in wagons covered with canvas or other suitable material and upon reaching the street shall have a temperature between *275* degrees F. and 350 degrees F. The temperature of the surface mixture within these limits shall be regulated according to the temperature of the atmosphere and the working of the mixture and the character of the materials employed. On reaching the street it shall at once be dumped on a spot outside of the space on which it is to be spread. *Loads shall not be dumped any faster than they can be properly handled by the shovelers.* It shall then be deposited roughly in place by means of hot shovels, after which it shall be uniformly spread by means of hot iron rakes in such manner that after having received its final compression by rolling, the finished pavement shall conform to the established grade. *The shovelers shall not distribute the dumped load any faster than it can be properly handled by the rakers. The rakers will not be permitted*

to stand in the hot mixture while raking it except where necessary to correct errors in the first raking. The thickness of the finished surface mixture shall average ——— inches. Not more than a *fifteen* (*15*) per cent variation from the average thickness specified will be permitted in any one spot. Before the surface mixture is placed, all contact surfaces of curbs, manholes, etc. must be *lightly* painted with either hot or cut-back asphalt cement.

Immediately after raking, the mixture shall be compressed by hot tampers where it adjoins curbing, gutters, headers, manholes, etc. and in all places inaccessible to a roller. In all other places it shall be given its initial compression by rolling with a tandem steam roller weighing not less than 5 tons, as soon after being raked as it will bear the roller without undue displacement or hair cracking. Delays in rolling the freshly raked mixture will not be tolerated.

Unless otherwise ordered by the engineer, the rolling shall be conducted as follows: The initial compression shall be given by rolling in a direction parallel to the curb, after which the pavement shall be cross-rolled, or diagonally and then straight rolled, until a compression and contour is obtained which is satisfactory to the engineer. During the initial and / or final compression of the pavement the rollers should preferably be operated at a speed of approximately one hundred (100) feet per minute and when so engaged they will not be permitted to exceed a speed of one hundred fifty (150) feet per minute. Where necessary to moisten the roller to prevent the hot mixture from sticking to it, a mixture of kerosene and water should be sparingly applied to the large roll. With the permission of the engineer, steam or water may be substituted therefor, but the use of water in excessive amounts will not be allowed under any circumstances.

Note: Where the width of the street will not permit cross-rolling or where the type of construction renders it desirable, the engineer may change the method of rolling.

Where more than one hundred (100) square yards per hour of surface mixture are laid, two rollers will be required. Where two rollers are employed, a 5-ton tandem steam roller should be used for the initial compression and not lighter than an 8-ton tandem steam roller for the final compression. With the permission of the engineer a three-wheeled steam roller may be used for the final compression. All rollers used shall be in good condition and shall weigh not less than two hundred (200) pounds to the inch width of tread. They shall be operated by competent and experienced roller engineers and must be kept in continuous operation as nearly as practicable in such a manner that all parts of the pavement shall receive substantially equal compression. During an 8-hour day each roller must be engaged in actual rolling for not less than 6½ hours, not more than 1½ hours being allowed for cleaning fires, watering, etc.

After the pavement has received its initial compression by rolling and before the close of the day on which it was laid, it shall have a *small amount of portland cement or limestone dust swept over it in order to give it a pleasing appearance and color. Except with the permission of the engineer, this shall not be done until the pavement shall have been rolled sufficiently to establish if and where back patching will be necessary and until any such defects have been so remedied. In no case shall the sweeping of cement be carried on in such a manner as to permit the dust from it to blow or be carried on to the freshly raked mixture before it has been rolled.*

Joints between old and new pavements or between successive days' work shall be carefully made in such a manner as to insure a thoro and continuous bond between the old and new surfaces. Except when a rope joint is used, the edge of the old pavement shall be cut back on a bevel so as to expose a fresh surface, after which the hot surface mixture shall be placed in contact with it and raked to a proper depth and grade. Hot smoothers and / or tampers shall be carefully employed in such a manner as to heat up the old pavement sufficiently to insure a proper bond without burning it.

The finished pavement shall have a contour substantially conforming to the grade set by the engineer and shall be free from any depressions which will hold water or which exceed three-eighths (3/8) of an inch in depth as measured between any two points six (6) feet apart in a line conforming substantially to the grade and contour as set by the engineer. It must be free from porous or rough spots that will remain wet after the balance of the surface has dried. Such portions of the completed pavement as are defective in finish, compression or composition, or that do not comply in all respects with the requirements of these specifications, shall be taken up, removed and replaced with suitable material, properly made and laid in accordance with these specifications at the expense of the contractor. Whenever so ordered by the engineer, a space of twelve (12) inches next to the curb shall be coated with hot asphalt cement, which shall be ironed into the pavement with hot smoothing irons.

No wearing surface shall be laid *during rainy weather or* when in the opinion of the engineer the weather conditions are unsuitable. The finished pavement must be well protected from all traffic by suitable barricades until it is sufficiently cooled for use.

Wherever the pavement is laid alongside of brick or concrete gutters, street car tracks, manhole heads, or liners, it is *required* that the finished surface adjacent to them be left one-quarter (1/4) inch high in order to provide for subsequent compression by traffic and to avoid depressions which would otherwise be liable to occur at these points.

XI. Page 12, Section 16: Omit table and substitute:

Bitumen	*9.5 to 13.5%*
Total passing 200-mesh	*Not less than 10%*
Total passing 80-mesh	*Not less than 15%*

Total passing 40-mesh . . . . 15 to 50%
Total passing 10-mesh . . . . 10 to 35%

Page 12, Section 16, 2d paragraph, 9th and 10th lines: Omit 100 on each line.

XII. Add after Section 16, page 12:

17. *Plant—The plant used in manufacturing the pavement must be of the batch type and capable of mixing in the manner herein specified not less than 80 tons of surface mixture per day of eight hours and must be provided with separate chambers for heating and mixing the ingredients. The mixing shall be done in a twin-shaft mixer of the pugmill type capable of holding and properly mixing not less than a 750-pound batch of surface mixture. Each plant must be provided with asphalt kettles of such capacity that one filling of them will be sufficient for a day's run. There shall also be provided a 6- or 8-mesh rotary screen not less than 6 feet long, capable of separating the coarse and fine aggregate and delivering each to a separate compartment bin; bins and screen to be provided with overflow pipes. The hopper into which the hot aggregate is drawn from the bin must rest upon a set of scales so arranged that a definite weight of material can be weighed out of the bin and delivered to the mixer.*

The asphalt bucket used to measure and apply the asphalt must be balanced upon a set of scales and so arranged that the asphalt can be easily and quickly weighed and be applied in a thin sheet the full width of the mixer.

The plant shall be provided with an asphalt thermometer for the melting kettles, an electric pyrometer at the discharge chute of the drier, a platform scale and at least two inspector's armored thermometers.

The different kinds of sand and stone used shall be kept separate and such provisions as are deemed necessary by the engineer to keep them from becoming mixed shall be made by the contractor.

18. *Testing Equipment—The contractor shall provide and maintain in good order at the plant the following testing equipment, which may be used by the engineer or an inspector designated by him to determine the penetration of asphalt and asphalt cement, the grading of the mineral aggregate and such other tests as are deemed necessary:*

1 Penetration machine with needles, glass dish and thermometer.

1 Set of standard screens, 200, 100, 80, 50, 40, 30, 20, 10 square mesh, 1/4", 1/2", 3/4", 1", 1½" circular openings,

1 Laboratory sand scale,

1 Roll of manila paper for making pat tests.

All of the above mentioned apparatus shall be of standard type and approved by the engineer and shall be properly housed by the *contractor in a separate building or room not less than ten (10) feet by ten (10) feet and provided with a work-bench. This room shall be used exclusively for testing purposes by the contractor and the engineer or his inspector.*

Change numbering of subsequent sections as follows: P. 13, secs. 17 and 18 to 19 and 20; p. 14, secs. 19 and 20 to 21 and 22; p. 15, sec. 21 to 23; p. 17, secs. 22, 23, and 24 to 24, 25 and 26; p. 18, sec. 25 to 27; p. 19, secs. 26 and 27 to 28 and 29; p. 20, sec. 28 to 30; p. 21, secs. 29 and 30 to 31 and 32; p. 22, secs. 31 and 32 to 33 and 34.

XIII. Change first sentence, section 24, pages 17 and 18, Volatilization Test, to read as follows:

Fifty (*50*) grams of the sample shall be placed in a weighed tin box, two and *three sixteenths* (*2 3/16*) inches in diameter and *one and three eighths* (*1 3/8*) inches high, (*three*-ounce Gill style can, obtainable from the American Can Co.) and heated five (5) hours at 325° F.

Your committee desires to submit a supplementary report as follows:

The committee is of the opinion that the specifications as presented and modified are too lengthy, somewhat involved and contain considerable detail. It will be readily understood that this condition is the natural result of growth in the way of annual amendments which have been made without complete revision or rearrangement. It is suggested and recommended that the incoming committee very carefully rewrite the entire specifications with a view to condensation and simplification both of matter and arrangement.

This committee, in view of the required method of advance preparation and presentation of specification material, was unable to undertake so important and time-consuming task as the complete revision would now entail.

It is appreciated that considerable matter is now being added to these specifications by this committee but these additions are considered to be only temporary expedients subject to modification and simplification when the specifications are completely revised as to subject matter and arrangement by the incoming Committee on Sheet Asphalt Paving Specifications.

Respectfully submitted,
R. KEITH COMPTON, *Chairman*
L. KIRSCHBRAUN
EDGAR WITHROW

The changes above given were adopted by letter ballot of the members by votes varying from 11 for to 7 against to 18 for and none against, as shown by the report of the Canvassing Committee on page 406.

PRESIDENT NORTON: The Constitution provides this: "After discussion of the report upon the floor of the convention, a vote shall be had upon the submission of the proposed specifications, or amendment of existing specifications, to letter ballot or reference back to the Committee." The first matter is the discussion of these specifications as presented by the Chairman of the Committee. If there is no discussion, a motion is in order to refer these specifications to letter ballot.

The motion was duly made, seconded, put and carried.

PRESIDENT NORTON: The suggestion made for the revision of these specifications, I think, is a happy one, as in many cases these became somewhat complicated, but it is entirely within the power of the incoming President to arrange this with his committee for the coming year.

The next on the program is the report of the Committee on Bituminous Macadam, Bituminous Concrete, and Asphalt Block Pavements by Linn White, Chairman.

REPORT OF COMMITTEE ON SPECIFICATIONS FOR BITUMINOUS MACADAM, BITUMINOUS CONCRETE AND ASPHALT BLOCK PAVEMENTS

The Committee on Bituminous Macadam, Bituminous Concrete and Asphalt Block Pavements, beg to report as follows:

No revised specification is offered for adoption at the 1920 meeting, but the following recommendations and suggestions are offered for consideration.

1. The asphaltic cements specified for each of the three kinds of pavement under the jurisdiction of this committee, should be made uniform with each other and uniform with the specifications of the sheet asphalt committee and the committee for standard tests for bituminous materials in respect to origin, general properties and tests. Variations should, of course, be made in penetration and other related special properties required in various pavements.

The same uniformity should be reached in all tar-cement specifications. This will, of course, require conferences and cooperation between all committees concerned with bituminous materials. The same cooperation should be effected with the new committee on pavement foundations.

By these means only can really standard specifications be produced.

2. Under asphaltic or bituminous concrete we now have three separate specifications, viz: bituminous concrete with one product of the crushing plant, bitulithic and the so-called Topeka specifications.

These three should be combined in one specification comprising all the best qualities of each.

This specification should be carefully and concisely written, with as few alternatives as possible, in a form that may be used literally, so any competent engineer may supervise and direct the construction.

As the principal bitulithic patents have expired, the letter signed by Warren Brothers Co., published in connection with the asphaltic concrete specifications, stating that Topeka is a non-infringing specification, should be omitted from further publications.

Respectfully submitted,
Committee on Bituminous Macadam, Bituminous
Concrete and Asphalt Block Pavements,
By LINN WHITE, *Chairman*

PRESIDENT NORTON: Gentlemen, you have heard the report of the committee. Are there any remarks on the report as made?

MR. BLANCHARD: I would like to ask Chairman White if it is his intention next year to present only one specification for bituminous concrete? That was what I gathered from his recommendation.

MR. WHITE: I would like to explain a little further. Our Committee felt that the previous specifications in the three forms have been brought about by special circumstances, the bitulithic patent, of course, controlling certain features. It has seemed to our Committee that the present condition was brought about by the attempts to make the very best specifications we could that would be non-infringing.

I would say further that the present committee sent out a sort of questionnaire, not to all members of the society, but to city officials, city engineers, and those who would be immediately connected with the making of specifications, asking for an opinion or expression upon the desirability of continuing the present number of specifications. That questionnaire was sent out rather late, so our committee has a number of replies, but by no means all we expected. I think we sent out one hundred and twenty, and doubtless other replies will come in later which will be valuable for use of the incoming committee.

PRESIDENT NORTON: Further discussion? If not, gentlemen, the matter is before you, and I believe the report is not such as can be acted upon by the Convention except in one manner, and that is reference back to the committee for next year.

MR. WHITE: Mr. President, I wish to call attention to one item in this report, and ask for instructions and that is in reference to the publication of letters signed by Warren Brothers Company, with reference to the non-infringement, that have been published in the standard specifications.

SECRETARY BROWN: I might say that I have a large supply of copies of the present specification, and so it is not probable it will be reprinted until the committee has had an opportunity to make its report. What I would distribute on call at the present time, would be simply the old specifications, so that really this point does not need to come up for decision until the new committee report is made, and then the committee can omit it from the specifications, and when those specifications are adopted, the new edition would not contain it.

MR. WHITE: I beg to make a motion that this report be referred back to the incoming committee.

The motion was duly seconded, put and carried.

PRESIDENT NORTON: The next matter upon the program is "Brick Pavements," E. H. Christ, Chairman. This was published in the advance papers and no changes recommended.

After some discussion the report was referred back to the Committee for further consideration.

The next on the program is the report of the Committee on Cement-Concrete Pavements, E. R. Conant, Chairman. These specifications are published in the Proceedings for 1919.

REPORT OF COMMITTEE ON SPECIFICATIONS FOR PORTLAND CEMENT CONCRETE PAVEMENTS

Your Committee begs to report that after carefully reviewing the tentative specifications submitted at New Orleans last year, we deem it for the best interest of the Society to make a number of changes and additions, and that the same could be brought more clearly and intelligently to the members of this Society, we have re-drafted the specifications in their entirety and recommend that same be submitted to the members for letter ballot.

Attention is invited to one or two of the principal changes made.

First, as regards the question of reinforcement. The Committee recognizes the fact that the use of reinforcing material is rapidly increasing; that many states in their specifications for highway construction require steel reinforcing. The committee hardly feel safe in compulsory requirement of reinforcement at this time, but do state in the specifications that certain concrete pavement "should" be reinforced, instead of stating that the same "shall" be reinforced. Second, the two-course pavement is omitted from the proposed specifications.

Very respectfully,
E. R. CONANT
P. L. BROCKWAY
H. ELTINGE BREED
GEO. F. FISK
Committee

SPECIFICATIONS FOR PORTLAND CEMENT CONCRETE PAVEMENTS

1. *Material*

1. *Cement:* The cement shall meet the requirements of the Standard Specifications for Portland Cement adopted by the Ameri-

can Society for Testing Materials under its last approved specifications, with all subsequent amendments and additions thereto which may be adopted by said society.

2. *Fine Aggregate:* Fine aggregate shall consist of natural sand or screenings from crushed rock, the particles of which are tough, hard and durable. When dry they shall be uniformly graded and all of the product shall pass a screen having four meshes per linear inch. The grading shall be such that not more than 25 per cent shall pass a screen having 50 meshes per linear inch and not more than 5 per cent shall pass a sieve having 100 meshes per linear inch. Fine aggregate shall not contain organic or other deleterious matter, nor more than 5 per cent of clay or loam, and for determining organic and other deleterious matter the colorimetric test shall be applied.

Fine aggregate shall be of such quality that mortar composed of one part portland cement and three parts fine aggregate by weight when made into briquettes shall show a tensile strengh at 7 and 28 days, at least equal to the strength of briquettes composed of one part of the same cement and three parts standard Ottawa sand by weight. The percentage of water used in making the briquettes of cement and fine aggregate shall be such as to produce a mortar of the same consistency as that of the Ottawa-sand briquettes of standard consistency. In other respects, all tests shall be made in accordance with the prevailing report of Committee on Uniform Tests of Cement of the American Society of Civil Engineers.

3. *Coarse Aggregate:* Coarse aggregate shall consist of clean, hard, durable and uniform crushed rock, gravel or pebbles in graded sizes, free from vegetable or other deleterious matter and containing no soft, flat or elongated particles.

The sizes of the coarse aggregate shall be such as to pass a 2¾-inch round opening, and shall range from 2¾ inches down, not more than 5 per cent passing a ¼-inch round opening, and with no intermediate sizes removed.

4. Water shall be clean, free from oil, acid, alkali, organic matter and other deleterious substances.

2. *Proportions*

5. All proportions of cement, fine aggregate and coarse aggregate shall be determined on the basis of screen analysis with a view to obtaining a uniform density for the resulting concrete.

6. The proportions will be in the ratio of one part of cement to not more than six parts of other aggregate, the exact proportions to be determined by screen analysis.

7. In no case shall the volume of fine aggregate be less than one-half the volume of the coarse aggregate, nor shall the proportion of cement to fine aggregate be leaner than one to two. A

cubic yard of concrete in place shall contain not less than six bags of cement.

8. The amount of water to be used shall be such that when the concrete is deposited the same will settle but not flow.

3. *Forms*

9. Steel forms shall be used, but as an alternative, where steel forms cannot be obtained, wooden forms may be used, in which case they shall be of such dimensions as will avoid warping and springing out of place.

10. *Setting:* The forms shall be well staked or otherwise held to the established lines and grades.

11. All mortar and dirt shall be removed from the forms. Precaution shall be taken to prevent leaks thru side forms that would allow the cement or mortar to be carried out of the coarser aggregate along the edges of the roadway. The concrete adjacent to the forms shall be worked to avoid porous concrete.

4. *Measuring Materials and Mixing Concrete*

12. *Measuring Materials:* The method of measuring the materials for the concrete, including water, shall be one which will insure separate and uniform proportions of the materials at all times. A bag of portland cement (94 pounds net) shall be considered one cubic foot.

13. *Mixing:* The materials shall be mixed in a batch mixer with batch meter and water-measuring device. The mixing shall continue for at least one minute before any part of the batch is discharged from the drum. The drum shall be completely emptied before receiving materials for successive batches.

14. *Retempering:* Retempering of mortar or concrete which has partially hardened, that is, remixing with or without additional materials or water, shall not be permitted.

5. *Reinforcement*

15. Reinforcing materials shall consist of a steel fabric manufactured from steel which shall develop an ultimate tensile strength of not less than 70,000 pounds per square inch, which when subjected to a bending test cold shall bend 180 degrees around one diameter and straighten without fracture. Reinforcement shall be free from excess rust, scale or coating of any character which will impair its bond with the concrete.

16. Concrete pavements 20 feet or under in width should be reinforced thruout with a steel fabric having an effective weight of not less than 30 pounds per 100 square feet, members to be at right angles. Reinforcement to be laid with the main members across the pavement. The ratio of effective area across the pavement shall approximate four to one along the axis of the pavement. The spacing of the main members of the fabric shall not be more

than 6 inches, nor less than 4 inches. Tie members to be not more than 12 inches nor less than 8 inches.

Concrete pavements wider than 20 feet should be reinforced with a steel fabric having an effective weight of not less than 30 pounds per 100 square feet, which shall be increased in weight one pound for each foot of width of pavement up to 50 feet.

17. *Placing:* Reinforcement shall be placed at right angles to the axis and generally two inches below the surface of the pavement. But under special soil conditions the fabric shall be placed as shown on plans. The fabric shall extend to within two inches of the ends and sides of the slabs. Laps shall be one-half the spacing of the members.

6. *Placing Concrete*

18. *Placing:* Immediately prior to placing the concrete, the sub-grade shall be brought to an even surface, in accordance with specifications and recommendations of the Committee on Foundations. The sub-grade shall be thoroly wetted to prevent absorption of water from the concrete but shall show no pools of water when concrete is laid.

After mixing, the concrete shall be deposited rapidly upon the sub-grade to the required depth to receive the reinforcing and for the entire width of the pavement in successive batches and in a continuous operation. Immediately thereafter the concrete above the reinforcement shall be placed in like manner. The use of intermediate forms or bulkheads between joints should not be permitted.

In case of a breakdown, concrete shall be mixed by hand to complete these sections or an intermediate transverse joint placed at the point of stopping work, provided that no slabs shall be less than 15 feet in length.

19. *Finishing:* The concrete, after being deposited in the area to be paved, shall be shoveled into position, bringing the surface approximately to grade, after which it shall be finished with a heavy screed cut accurately to the proposed shape of the finished roadway and shod with metal. This screed shall be used with a tamping movement to bring the concrete to the proper grade and work out air bubbles and any excess water, care being taken to have a small excess of concrete in front of the screed at all times. Should spots of porous concrete appear, suitable material shall be added and the surface rescreeded. In case the pavement is of such width as to make impracticable the use of the screed, the concrete may be placed by means of a lute or solid rake, stakes being set not to exceed five feet apart with their tops at proper elevation.

After screeding or luting, the surface shall be further smoothed by the use of a metal roller, weighing approximately 15 pounds per linear foot of width and from 8 to 12 inches in diameter by 6 feet wide, worked across the roadway, and the surface finished by drawing a rubber garden hose or a rubber belt along the surface while still wet. Should a mechanical finisher be used, care must be taken to keep the mixture sufficiently dry.

The finished surface of the pavement shall in no case vary more than ¼ inch from the specified contour.

Split floats shall be used at the joints.

7. *Protection*

20. *Curing and Protection:* Excepting as hereinafter specified, the surface of the pavement shall be sprayed with water as soon as the concrete is sufficiently hardened to prevent pitting, and shall be kept wet until an earth or other approved covering is placed. As soon as it can be done without damaging the concrete, the surface of the pavement shall be covered with not less than 2 inches of earth or other material approved by the engineer, such as straw, marsh grass, hay, etc., which cover shall be kept wet for at least ten days. When deemed necessary or advisable by the engineer, freshly laid concrete shall be protected by canvas until such covering can be placed. When the pavement is level enough to permit of it, curing may be done by ponding.

Under the most favorable conditions for hardening in hot weather, the pavement shall be closed to traffic for at least fourteen days and in cool weather for an additional time, to be determined by the engineer.

The contractor shall erect and maintain suitable barriers to protect the concrete from all traffic and any part of the pavement damaged from traffic or other causes occurring prior to its official acceptance shall be repaired or replaced by the contractor at his expense, in a manner satisfactory to the engineer. Before the pavement is thrown open to traffic the covering shall be moved and disposed of as directed by the engineer.

21. *Temperature below 35 Degrees F.:* Concrete shall not be mixed or deposited when the temperature is below freezing. If at any time during the progress of the work the temperature is, or in the opinion of the Engineer will within 24 hours drop to 35 degrees F., the water and aggregates shall be heated, and precautions taken to protect the work from freezing for at least ten days. In no case shall the concrete be deposited upon a frozen sub-grade.

The above specifications were adopted by letter ballot of the members by votes varying from 13 for to 4 against to 16 for to 1 against as shown by the report of the Canvassing Committee on page 406.

Mr. Conant: I move that these specifications be referred to letter ballot.

The motion was duly seconded, put and carried.

PRESIDENT NORTON: The next specifications are those for Stone-Block Pavements, Mr. H. H. Smith, Chairman. These were printed in the proceedings for 1919.

REPORT OF COMMITTEE ON SPECIFICATIONS FOR STONE BLOCK PAVEMENTS

Your Committee on Stone Block Pavements recommends the following changes in the specifications for Stone Block Pavements:

Section 1, Par. 4. Change 6 tests for determining the "French Co-Efficient of Wear" to 3 tests.

Section 2, Par. 1. Change "certified copy" to true copy.

Section 2, Par. 2. Add the following: Any bidder who has on file accepted samples as above described need not file additional samples with successive bids, but refer to the same in a letter. He must, however, determine that the samples are on file.

Section 4. Add the following: The stone from each quarry shall be piled and laid separately in different sections of the work, and in no case shall the stones from different quarries be mixed.

Section 5, Par. 2. Change "not more than six inches wide on top" to not more than five inches wide on top.

Section 6, second line. Change "must" to should.

Between Sections 6 and 7 insert Specification for Durax Block as follows:

7. *Durax Paving Blocks:* Durax Paving Blocks shall be cut from granite complying with the requirements specified herein for new granite paving blocks.

The blocks shall be cubes of granite with six approximately square surfaces, the edges of which measure not more than four (4) nor less than three (3) inches in length. They shall be dressed so as to conform with the requirements specified for new granite blocks except as to form and dimensions.

They shall be laid as specified for new granite blocks except that the courses shall be laid in circular concentric arcs with the largest blocks at the center of the arc and the smaller ones at the spring-line; the radii of the arcs may be varied from 3 to 7 feet.

Sections 7 and 8. Wherever the word "sub-foundation" occurs in these sections it has been changed to sub-grade. The last paragraph is eliminated.

Section 9. At end of sentence in the third line add the following: The cushion course may be made of a mixture of sand as above described mixed with an equal portion of portland cement, spread on the concrete bed and the blocks paved in the same manner as hereinbefore described.

The balance of this paragraph beginning with the words "Upon this sand bed" is eliminated from Section 9 and placed at the beginning of Section 10, under the heading Laying the Pavement.

Section 10. The heading is changed from "Ramming" to Laying the Pavement. Begin the Section by inserting balance of paragraph 9 beginning with the words "Upon this sand bed, etc."

Section 11. Add to this Section a fourth alternative consisting of a filler composed of a mixture of tar and asphalt, this filler to be known as alternative (C) the cement grout filler to be changed from alternative (C) to alternative (D).

Between Sections 13 and 14 insert new Section specifying the tar and asphalt mixture as follows:

Tar and Asphalt Filler: The mixture of coal tar pitch and refined asphalt shall be composed of 100 parts of coal-tar pitch and 20 parts of refined asphalt. The tar and asphalt shall each comply with the requirements herein specified in Sections 13 and 14 except that the penetration of the asphalt at 77° F. shall be not less than 30 nor more than 40. The tar and asphalt filler shall be mixed with sand and used in the same manner as the coal-tar or asphalt filler described in Sections 13 and 14.

Sec. 13 paragraph 2 eliminate the word dry in the third line.

Eliminate the note at the end of the Specifications which refers to the use of 4-inch granite blocks.

Renumber all Sections.

At the 1919 Meeting of the Society Mr. T. J. Wasser presented a specification for stone block pavement published on pages 607 to 620 of the 1919 proceedings, and your Committee was requested to report its findings regarding Mr. Wasser's specifications to the 1920 Convention of the Society.

We have made a careful study of Mr. Wasser's specifications and have discussed the changes he proposes with many members of the Society and with manufacturers of paving blocks. It is the consensus of opinion of your Committee that nothing would be gained by adopting the change of form proposed and also that practically every point brought out by Mr. Wasser is now fully covered. Such additions or changes as the Committee felt justified in making are embodied in the list of changes noted at the beginning of this report. The more radical changes, which consist of an entire rearrangement of the subject matter and the addition of considerable detail, it has not been thought wise to adopt. The standard Specifications are widely used and printed and these changes would tend to cause considerable confusion in the many localities where they have become the standard.

The Committee is convinced that our present standard Specifications with the changes herein presented are as clear, concise and practical as it is possible to make them with the data available.

Attached to this report is a copy of the specifications as amended by this report and the committee requests that the amended Specifications be printed in the 1920 proceedings so that it may be adopted by the convention in 1921.

HERMAN H. SMITH, *Chairman*
R. KEITH COMPTON
E. A. FISHER

The italics in the following show the changes in the stone block paving specifications made above. Thru inadvertence these revised specifications were submitted to letter ballot with those adopted at the Convention and received a majority of the votes cast, as shown by the Canvassing Committee on page 406.

SPECIFICATIONS FOR STONE BLOCK PAVING

NEW GRANITE PAVING BLOCKS

1. The paving blocks shall be of medium grained granite, showing an even distribution of constituent minerals, of uniform quality, structure and texture, without seams, scales or disintegration, free from an excess of mica or feldspar, and equal in every respect to the sample in the office of the engineer.

Tests

For heavy traffic the granite shall have a toughness of not less than nine (9) and a "French Co-efficient of Wear" of not less than eleven (11). For medium traffic, the granite may have a toughness of not less than seven (7) and a "French Co-efficient of Wear" of not less than eight (8) if a cement grout filler is used.

The above tests shall be made by the methods described in Bulletin No. 44, U. S. Department of Agriculture, Office of Public Roads.

The average of three (3) tests shall be used for determining toughness and the average of *three* (3) tests for determining the "French Co-efficient of Wear."

Certificates and Samples

2. Contractors shall file with the engineer at or before the time of bidding, a certificate showing the name and location of the quarry from which it is proposed to obtain the blocks, also a true copy of a report from the United States Department of Agriculture, showing the toughness and "French Co-efficient of Wear" of the granite which it is proposed to use.

On or before the date of the letting, six (6) specification blocks, made from the granite it is proposed to use, shall be filed with the engineer. *Any bidder who has on file accepted samples as above described need not file additional samples with successive bids, but may refer to the same in a letter. He must, however, determine that the samples are on file.*

3. The blocks shall be of the following dimensions: Not less than eight (8) nor more than twelve (12) inches long on top; not less than three and one-half (3½) nor more than four and one-half (4½) inches wide on top; not less than four and three-quarters (4¾) nor more than five and one-quarter (5¼) inches deep.

The blocks shall be so dressed that the faces will be approximately rectangular in shape, and the ends and sides sufficiently smooth to permit the blocks to be laid with joints not exceeding one-half (½) inch in width at the top, and for one (1) inch downward therefrom, and not exceeding one (1) inch in width at any other part of the joint. The top surface of the block shall be so cut that there will be no depressions measuring more than three-eighths (⅜) of an inch from a straight edge laid in any direction on the top and parallel to the general surface thereof.

Care shall be exercised in handling the blocks, so that the edges and corners shall not be chipped or broken, as blocks otherwide acceptable may be rejected on account of spalling.

4. The blocks shall be sorted and laid in courses of uniform width, except in special cases, as may be ordered. *The stone from each quarry shall be piled and laid separately in different sections of the work, and in no case shall the stones from different quarries be mixed.*

NEW SANDSTONE PAVING BLOCKS

5. The paving blocks shall be of sound, hard sandstone, free from clay, seams, or defects which would injure them for paving purposes, of uniform quality and texture, and equal in every respect to the sample in the office of the engineer.

The blocks shall be of the following dimensions: Not less than eight (8) nor more than ten (10) inches long on top; not less than three and one-half (3½) nor more than *five* (5) inches wide on top; not less than four and three-quarters (4¾) nor more than five and one-quarter (5¼) inches deep.

RECUT OR REDRESSED PAVING BLOCKS

6. When the use of blocks recut from old paving blocks is permitted, such blocks *should* comply with the specifications for quality of stone, as required for new blocks. The dimensions may be varied, depending upon the size of the old blocks which are to be redressed, and the character of the pavement which it is sought to obtain.

DURAX PAVING BLOCKS

7. *Durax paving blocks shall be cut from granite complying with the requirements specified herein for new granite paving blocks.*

The blocks shall be cubes of granite with six approximately square surfaces, the edges of which measure not more than four (4) nor less than three (3) inches in length. They shall be dressed so as *to conform with the requirements specified for new granite blocks except as to form and dimensions.*

They shall be laid as specified for new granite blocks except that the courses shall be laid in circular concentric arcs with the largest blocks at the center of the arc and the smaller ones at the springing line. The radii of the arcs may be varied from three (3) to seven (7) feet.

SUB-GRADE

8. Any soft or spongy material below the sub-grade shall be replaced with sand, gravel, or other material, as directed by the engineer, and thoroly rammed or rolled. When such extra fill exceeds five (5) cubic yards, payment will be made for the excess.

Care shall be taken in excavating not to disturb the *sub-grade*, except where necessary to remove the soft or spongy material.

CONCRETE BASE

9. After the *sub-grade* has been prepared to the satisfaction of the engineer, a concrete foundation six (6) inches thick shall be laid thereon. The concrete shall conform to the A.S.M.I. specifications for concrete for pavement foundations.

The grading and *sub-grade* shall be completed at least fifty (50) feet in advance of the laying of concrete.

CUSHION COURSE

10. On the concrete base shall be spread a layer, averaging one (1) inch in depth, of clean, coarse, dry sand, free from all gravel exceeding one-quarter (¼) inch in size. *The cushion course may be made of a mixture of sand as above described, mixed with an equal portion of portland cement, spread on the concrete bed and the blocks paved in the same manner as herein described.*

LAYING THE PAVEMENT

11. Upon this sand bed the blocks shall be laid in courses at right angles to the line of the street, and in a straight line from curb to curb, except in special cases, when they shall be laid at such an angle as may be directed by the engineer. The blocks shall be laid as closely as possible, each block touching the adjoining one on sides and ends, and in courses of uniform width. All joints shall be broken with a lap of at least three (3) inches. The blocks shall not be laid more than twenty-five (25) feet in advance of the ramming. After the blocks are laid, they shall be rammed to a solid bearing, the joints shall be adjusted, all unsatisfactory blocks shall be taken out with tongs and all low blocks shall be raised to an even and true surface. Pinch-bars shall not be used except by special permission of the engineer and no sand shall be placed in the joint except when mixed with the filler specified hereafter.

FILLING JOINTS

12. The following specifications A, B, C *and* D, shall govern the use of—Tar Pitch (A)—Asphalt (B)—*Tar-Asphalt mixture* (*C*) or cement grout (*D*), depending upon the kind of filler to be used in the joints:

A—Tar Pitch Filler

13. The joint filler used shall be the paving pitch hereafter described, thoroly mixed with as much hot, dry sand as the pitch will carry, but in no case shall the volume of the sand exceed the volume of the pitch. The sand shall be fine and clean and all of it shall pass a 20-mesh screen. It shall be heated to a temperature of not less than 300 deg. F., nor more than 400 deg. F., and shall be between these limits when mixed with the paving pitch.

The paving pitch shall be heated in kettles properly equipped with an approved thermometer, which shall register the temperature of the pitch.

The mixture shall be flushed on the surface of the blocks and pushed into the joints with suitable tools, re-flushing or re-pouring, if necessary, until the joints remain permanently filled flush with the surface of the pavement. As little as possible of the mixture shall be left on the surface.

The tar pitch shall comply with the following requirements:

(a) It shall have a specific gravity between 1.23 and 1.33 at 60 degrees Fahr.

(b) It shall have a melting point between 115 and 135 degrees Fahr., determined by the cube method in water.

(c) It shall contain not less than twenty (20) per cent nor more than thirty-five (35) per cent of free carbon insoluble in hot benzol or chloroform.

(d) It shall contain not more than one-half (½) per cent of inorganic matter.

(e) It shall be free from water.

(f) It shall have a ductility of not less than sixty (60) centimeters at 77 degrees Fahr.

The tar pitch shall be used on the work at a temperature of not less than two hundred and fifty (250) degrees Fahr., and shall at no time be heated above three hundred and twenty-five (325) degrees Fahr.

It shall be delivered where directed by the engineer at least one week before being used, to allow for examination and analysis.

In applying the filler, care shall be taken that the pavers are closely followed by the filler gang, and in no case shall the paving be left over night, or when work is stopped, without the filling of the joints being completed. In case rain stops the filler gang before its work is finished, the joints shall be protected by the use of tarpaulins, or other means to keep out water. Under no circumstances shall the filler be poured into wet joints.

B—Asphalt Filler

14. The joint filler used shall be the asphalt cement hereafter described, thoroly mixed with as much hot, dry sand as the cement will carry, but in no case shall the volume of the sand exceed the volume of the cement. The sand shall be fine and clean and all of it shall pass a 20-mesh screen. It shall be heated to a temperature of not less than 300 deg. F., nor more than 400 deg. F., and shall be between these limits when mixed with the cement.

The asphalt cement shall be heated in kettles properly equipped with an approved thermometer, which shall register the temperature of the cement.

The mixture shall be flushed on the surface of the blocks and pushed into the joints with suitable tools, reflushing, or repouring, if necessary, so that the joints remain permanently filled flush with the surface of the pavement. As little as possible of the mixture shall be left on the surface.

The asphalt paving cement shall be obtained by the distillation of an asphaltic petroleum at a temperature not exceeding 700 deg. F., and shall comply with the following requirements:

(a) It shall be homogeneous.

(b) Melting point shall not be less than 130 deg. F., nor more than 145 deg. F.

(c) Solubility in carbon tetrachloride shall not be less than ninety-eight and one-half (98½) per cent.

(d) Penetration at 77 deg. F. shall not be less than 60 nor more than 100, the penetration test being made with a No. 2 needle for five (5) seconds under a load of 100 grams, and the penetration at 100 deg. F., shall not exceed three (3) times its penetration at 77 deg. F., the conditions of time and load being as above established. The contractors before beginning work shall obtain from the engineer a statement in writing as to the penetration desired for any particular contract, and a variation of not greater than ten (10) points either way from this penetration will be permitted.

(e) Ductility at 77 deg. F. shall not be less than 40 centimeters, the rate of elongation being five (5) centimeters per minute.

(f) It shall not lose more than three (3) per cent by volatilization when maintained at a temperature of 325 deg. F. for five (5) hours, nor shall the penetration of the residue after such heating be less than one-half of the original penetration.

The asphalt filler shall be used on the work at a temperature of not less than 275 deg. F., and shall at no time be heated above 350 deg. F.

It shall be delivered where directed by the engineer in time to allow for examination and analysis.

In applying filler, care shall be taken that the pavers are closely followed by the filler gang, and in no case shall the paving be left over night, or when work is stopped, without the filling of the joints being completed. In case rain stops the filler gang before its work is finished, the joints shall be protected by tarpaulins or other means, so as to keep out water. Under no circumstances shall the filler be poured into wet joints.

C—Tar and Asphalt Filler

15. *The mixture of coal tar pitch and refined asphalt shall be composed of 100 parts of coal tar pitch and 20 parts of refined asphalt. The tar and the asphalt shall each comply with the requirements herein specified in Sections 13 and 14, except that the penetration of the asphalt at 77 deg. F. shall be not less than 30 nor more than 40. The tar and asphalt filler shall be mixed with sand and used in the same manner as the coal tar or asphalt filler described in Sections 13 and 14.*

D—Cement Grout Filler

16. After the pavement has been brought to a uniform surface, portland cement grout shall be poured into the joints until it appears on the surface. The grout shall be broomed or scraped into the joints, if necessary to fill the same, and the operation shall be repeated as the grout settles, and before the initial set has taken place, until the joints are thoroly filled flush with the surface of the blocks. Immediately after this, the entire pavement shall be broomed to a smooth surface. The blocks shall be wetted immediately before applying the grout.

The cement grout shall be composed of one (1) part of portland cement and one (1) part of clean sharp sand. The cement and sand shall be thoroly mixed and only enough fresh water shall be added to make a grout which will flow to the bottom of the joints.

The grout shall be machine mixed in a batch mixer approved by the engineer and shall be applied to the joints before the ingredients have separated. After the grouting is completed and a sufficient time for hardening has elapsed so that a coating of sand will not absorb moisture from the cement mixture, one-half (½) inch of sand shall be spread over the whole surface and shall be kept damp until the street is opened for traffic.

After the grouting is completed, the street shall be kept closed and no carting or traffic allowed on any part of the grouted pavement until at least seven days have elapsed.

Should the bond between the blocks become broken before the work is accepted, such defective work shall be regrouted or relaid and again barricaded as previously described.

MR. SMITH: I move that the report be printed and referred back to the Committee.

The motion was duly seconded, put and carried.

PRESIDENT NORTON: The next report is from the Committee on Sewers, W. W. Horner, Chairman.

REPORT OF COMMITTEE ON SPECIFICATIONS FOR SEWER CONSTRUCTION

Your committee on specifications for sewers has carefully considered the existing specifications of the Society. The committee has reached the conclusion that the Society's specifications are no longer satisfactory on account of new materials and new methods of sewer construction, which have been introduced since their adoption six years ago. The committee feels that the specifications for sewers should be entirely rewritten.

The committee has agreed on a form of specifications, as follows:

Part 1. Specifications for materials for sewer construction.

Part 2. Specifications for methods of sewer construction.

Your committee by correspondence thruout the past year has carefully covered existing specifications for sewer materials and tentatively agreed on this portion of the specifications. This Part 1 of the final specifications, as tentatively approved by the Committee, is presented herewith, with the request that it be printed in the Proceedings, and that the membership be asked to study it carefully in the near future and to communicate directly to the chairman of the committee, all suggestions as to advisable revision.

With the assistance of the membership, the Sewer Committee of next year should be able to complete the specifications in entirety, and should be prepared to present this for final publication prior to adoption in advance of the next annual Meeting.

Respectfully submitted,
E. S. DORR
C. L. HOWELL
ALEXANDER POTTER
W. G. KIRKPATRICK
W. W. HORNER, *Chairman*

PROPOSED STANDARD SPECIFICATIONS FOR SEWERS

PART I. MATERIALS

Cement

1. All cement shall conform to the current specifications for portland cement of the American Society for Testing Materials, and shall be tested in accordance with the methods of testing described in the specifications of that Society.

2. The engineer is to be notified of the location of wharves, yards or sheds where the cement is to be stored. No cement will be tested in cars, in course of transportation or on the street. All cement not satisfactory to the engineer is to be branded and immediately removed and all cement accepted by him to be so marked and kept in a weather-tight store-house, having a tight floor a proper distance above the ground. A sufficient quantity shall be kept in storage to allow for seven (7) day tests, and if required, twenty-eight (28)-day tests. Cement kept in storage may be subjected to repeated tests. Cement in bags shall not be piled to height exceeding seven (7) feet.

Hydrated Lime

3. Hydrated lime shall conform to the current specifications for hydrated lime of the American Society for Testing Materials and shall be tested in accordance with the methods of testing described in the specifications of that Society.*

Sand

4. Sand shall be of the best quality locally obtained and shall be clean, coarse, free from dirt, vegetable loam, organic acids or other deleterious matter. It shall contain not more than four (4) percent by volume of clay and no clay shall be artificially added.

5. *Grading for Mortar:* Sand for mortar shall be graded from fine to coarse and passing when dry a screen having 10 meshes per linear inch and not less than ninety-four (94) percent retained on a sieve having 100 meshes per linear inch.

6. *Grading for Fine Aggregate for Concrete:* Sand for fine aggregate for concrete shall be graded from fine to coarse and passing when dry a screen having holes one fourth (¼) inch in diameter and not less than ninety-four (94) percent retained on a sieve having 100 meshes per linear inch.

7. *Tests:* Sand shall be of such quality that mortars composed of the proportions of cement and sand hereinafter specified for the various classes of concrete shall show a compressive strength after fourteen (14) days at least equal to the strength of mortar made of portland cement and standard Ottawa sand in corresponding proportions and of the same consistency.

8. *Samples:* Samples of not less than one-half (½) cubic foot of fine aggregate shall be delivered in suitable boxes or containers. All samples shall be plainly labeled with the places where taken, where to be used, the date and the name of the collector.

Coarse Aggregate

9. *Quality:* Coarse aggregate shall consist of crushed stone, gravel or blast-furnace slag, which is retained on a screen having holes one-fourth (¼) inch in diameter and graded from the smallest

---

* Hydrated lime is commercially divided into four classes, high-calcium, calcium, magnesian and high-magnesian and the particular class lime desired should be specified in each case.

to the largest particles. It shall be sound, hard and durable; be free from loam, clay, organic matter and all deleterious material and shall not contain any soft, flat or elongated particles. Crusher dust in sufficient quantity to weaken the concrete will not be permitted.

10. *Maximum Sizes:* For plain and reinforced arches where steel spacing is two (2) inches or less from face, the maximum size of particles shall be such as will pass a screen having holes one (1) inch in diameter. For inverts, plain arches over six (6) inches in thickness, and reinforced arches where spacing of steel is greater than two (2) inches, the maximum size of particles shall be such as will pass a screen having holes one and one-half (1½) inches in diameter.

11. *Samples:* Samples of not less than one (1) cubic foot of coarse aggregate shall be delivered in suitable boxes or containers. All samples shall be plainly labeled with the place where taken, where to be used, the date and name of the collector.

12. *Tests:* Where crushed rock is used it shall have a specific gravity of not less than two and six-tenths (2.6) and shall have a French coefficient of wear of not less than eight (8) as described in bulletins No. 347 and 370 of United States Department of Agriculture.

Common Brick

13. *Quality:* Common bricks shall be sound, burnt hard entirely thru, of compact texture, with true even faces and rectangular edges. At least one edge-face of each brick shall be such that if laid on a horizontal plane, no portion of that face shall be more than one-eighth (⅛) inch from that plane. Brick shall be regular in size and shape and for use on any one contract shall vary not more than one-eighth (⅛) inch in dimension.

14. *Samples, Tests, Inspection:* Each shipment of between twelve thousand (12,000) and twenty thousand (20,000) brick shall be sampled. Each sample shall be subjected to cross-breaking and crushing tests under the three (3) conditions given below, the brick to be tested flat and any unevenness in the surface to be leveled up with a plaster of paris bed.

(1) After having been thoroly dried.
(2) After having been immersed in water for twenty-four (24) hours.
(3) After being subjected to twenty (20) freezings alternating with twenty (20) thawings.

15. The following figures fix minimum and average values to be met by the brick after the above treatment.

	Modulus of Rupture Lb. per sq. in.		Crushing Strength Lb. per sq. in.	
	Minimum	Average	Minimum	Average
(1) Dried	350	500	3000	4000
(2) Wet	300	450	2500	3500
(3) Frozen & Thawed	225	275	2000	2500

16. The absorption of the brick after immersion in water for twenty-four (24) hours shall not exceed fifteen (15) percent of the weight of the dry brick.

17. All brick must be satisfactory in every respect to the engineer and subject to his acceptance or rejection.

Vitrified Brick

18. *Quality:* Vitrified brick shall be sound, uniformly vitrified and annealed, be free from lime or other impurities, with true even faces and rectangular edges. At least one edge-face shall be such that, if laid on a horizontal plane, no portion of that face shall be more than one-eighth (⅛) inch from that plane. Brick shall be regular in size and shape and for use on any one contract shall vary not more than one-eighth (⅛) inch in dimensions.

19. *Inspection, Samples, Tests:* All brick shall be satisfactory to the engineer and subject to his acceptance or rejection.

20. Brick shall be sampled and submitted to a standard rattler test and shall not show a loss of more than twenty-eight (28) percent. This test shall be made according to the method adopted by the American Society for Municipal Improvements in 1914 for Paving Brick.

21. Brick after having been thoroly dried and then immersed in water for twenty-four (24) hours shall not absorb more than four (4) percent of their weight of water.

Vitrified Sewer Pipe

22. *Quality:* Sewer pipe shall be of the best quality of standard hard-burned, salt-glazed, vitrified clay or shale pipe, shall be free from blisters, cracks and pronounced laminations and must give a metallic ring when struck with a hammer. All pipes shall be socket pipes with sockets true, circular and concentric with the base of the pipe, and the plane of the ends at right angles to the axis of the pipe. The inner surface of the socket and the outer surface of the spigot end shall be scored by triangular shaped or semicircular rings about one-eighth inch deep.

23. *Sizes and Dimensions:* Pipes shall be furnished of the sizes, internal diameter, and with the minimum dimensions given in the following table:

Internal Diameter In.	Laying Length Ft.	Inside Diam. at Mouth of Socket. In.*	Depth of Socket In.	Minimum Taper of Socket In.	Thickness of Barrel In.	Thickness of Socket
6	2	8¼	2	1:20	⅝	The thickness of the socket ¼ in. from its outer end shall not be less than ¾ of the thickness of barrel of the pipe
8	2, 2½, 3	10¾	2¼	1:20	¾	
10	2, 2½, 3	13	2½	1:20	⅞	
12	2, 2½, 3	15¼	2½	1:20	1	
15	2, 2½, 3	18¾	2½	1:20	1¼	
18	2, 2½, 3	22¼	3	1:20	1½	
21	2, 2½, 3	26	3	1:20	1¾	
24	2, 2½, 3	29½	3	1:20	2	
27	3	33¼	3½	1:20	2¼	
30	3	37	3½	1:20	2½	
33	3	40¼	4	1:20	2⅝	
36	3	44	4	1:20	2¾	

* When pipes are furnished having an increase in thickness over that given in the last column, the diameter of socket shall be increased by an amount equal to twice the increase in thickness of barrel.

24. The permissible variation from the dimensions given in the above table shall not exceed those stated below.

Internal Diameter In.	Limits of Permissible Variation in					
	Length In. per Ft. (−)	Length of Two Opposite Sides In.	Internal Diameter		Depth of Socket In. (−)	Thickness of Barrel In. (−)
			Spigot (±)	Socket (±)		
6	¼	⅛	3/16	¼	¼	1/16
8	¼	⅛	¼	5/16	¼	1/16
10	¼	⅛	¼	5/16	¼	1/16
12	¼	⅛	5/16	⅜	¼	1/16
15	¼	⅛	5/16	⅜	¼	3/32
18	¼	3/16	⅜	7/16	¼	3/32
21	¼	3/16	7/16	½	¼	⅛
24	⅜	¼	½	9/16	¼	⅛
27	⅜	¼	⅝	11/16	¼	⅛
30	⅜	¼	⅝	11/16	¼	⅛
33	⅜	⅜	¾	13/16	¼	3/16
36	⅜	⅜	¾	13/16	¼	3/16

Note—The minus (−) sign indicates that the plus variation is not limited; the plus and minus (±) sign indicates variation in both excess and deficiency in dimension.

25. *Specials:* All special shapes shall have a plain spigot end and a socket end corresponding in all respects with the dimensions and specifications for pipes of corresponding internal diameter. Slants shall have their spigot ends cut at an angle of approximately forty-five (45) degrees with the longitudinal axis. Curves shall be at angles of ninety (90), forty-five (45), twenty-two and one-half (22½) degrees as required and shall conform substantially to curvature specified. Branches shall be furnished with the connection or connections of the size or sizes specified, securely and completely fastened by fusion in the process of vitrification to the barrel of the pipe and shall terminate in sockets. Y-branches shall have their axes approximately forty-five (45) degrees from the longitudinal axis of the pipe and T-branches shall be perpendicular to that axis.

26. *Inspection:* Pipes shall be subject to inspection either at the factory, trench, or point of delivery, the purpose of this inspection to be to cull and reject pipe which, independently of the physical tests herein specified, fail to comply with the requirement of these specifications.

27. *Tests:* The tests for pipe shall include the following:

(1) Sand-bearing crushing test.

(2) Hydrostatic test.

(3) Absorption test.

28. Tests shall be made according to the methods described in the current standard specifications of the American Society for Testing Materials for clay sewer pipe, and shall meet the requirements therein. One section shall be tested for each two hundred (200) linear feet or fraction thereof of each size of pipe to be laid,

the minimum number of specimens to be tested to be six (6) for each selection of each size of pipe.

Cement Concrete Pipe

29. *Quality:* Cement-concrete pipe shall be made of Class A concrete as defined in these specifications, and materials used shall meet the requirements of these specifications. Pipe shall be free from fractures, large or deep cracks and blisters, laminations and surface roughness. All pipe shall be socket pipe with sockets true, circular and concentric with the base of the pipe.

30. *Sizes and Dimensions:* Pipes shall be furnished of the sizes, internal diameters with the minimum dimensions given in the following table:

Internal Diameter In.	Laying Length Ft.	Inside Diam. at Mouth of Socket. In.*	Depth of Socket In.	Minimum Taper of Socket	Thickness of Barrel In.	Thickness of Socket
6	2, 2½,	8¼	2	1:20	⅝	The thickness of the socket ¼ in. from its outer end shall not be less than ¾ of the thickness of the barrel of the pipe.
8	2, 2½, 3	10¾	2¼	1:20	¾	
10	2, 2½, 3	13	2½	1:20	⅞	
12	2, 2½, 3	15¼	2½	1:20	1	
15	2, 2½, 3	18¾	2½	1:20	1¼	
18	2, 2½, 3	22¼	3	1:20	1½	
21	2, 2½, 3	26	3	1:20	1¾	
24	2, 2½, 3	29½	3	1:20	2	

* When pipes are furnished having an increase in thickness over that given in the last column, then the diameter of socket shall be increased by an amount equal to twice the increase in thickness of barrel.

31. The permissible variation from the dimensions given in the above table shall not exceed those stated in the following table.

Normal Size In.	Limits of Permissible Variation					
	Length, In. per Ft. (−)	Length of Two Opposite Sides In.	Internal Diameter		Depth of Socket In. (−)	Thickness of Barrel In. (−)
			Spigot (±)	Socket (±)		
6	¼	⅛	3/16	¼	¼	1/16
8	¼	⅛	¼	5/16	¼	1/16
10	¼	⅛	¼	5/16	¼	1/16
12	¼	⅛	5/16	⅜	¼	1/16
15	¼	⅛	5/16	⅜	¼	3/32
18	¼	3/16	⅜	7/16	¼	3/32
21	¼	3/16	7/16	½	¼	⅛
24	⅜	¼	½	9/16	¼	⅛

Note—The minus sign (−) indicates that the plus variation is not limited; the plus and minus sign (±) indicates variation in both excess and deficiency in dimension.

32. *Specials:* All specials shall have a plain spigot end and a socket end corresponding in all respects with the dimensions and specifications for pipes of the corresponding internal diameter. Slants shall have their spigot ends cut at an angle of approximately forty-five (45) degrees with the longitudinal axis. Curves shall be at angles of ninety (90), forty-five (45), twenty-two and one-half (22½) degrees as required and shall conform substantially to

curvature specified. Branches shall be furnished with the connection or connections of the size or sizes specified, securely and completely fastened in the process of manufacture to the barrel of the pipe and shall terminate in sockets. Y-branches shall have their axes at an angle of approximately forty-five (45) degrees with the longitudinal axis of the pipe and T-branches shall be perpendicular to that axis.

33. *Inspection:* All pipes shall be subject to inspection either at the factory, trench or point of delivery, the purpose of this inspection to be to cull and reject pipe which, independent of the physical tests herein specified, fail to comply with the requirements of these specifications. Pipes shall be subject to rejection on account of the following:

(a) Variation in any dimension exceeding the permissible variations given in above table.

(b) Fracture or cracks passing thru the shell or socket, except that a single crack at either end of a pipe not exceeding two (2) inches in length or a single fracture in the socket not exceeding three (3) inches in width nor two (2) inches in length will not be deemed cause for rejection unless these defects exist in more than five (5) percent of the entire shipment or delivery.

(c) Blisters where the surface is broken or which project more than one-eighth (1/8) inch above the surface.

(d) Defects which indicate imperfect mixing, molding or curing.

(e) Cracks sufficient to impair the strength, durability or serviceability of the pipe.

(f) Variation of more than one-eighth (1/8) inch per linear foot in alignment of a pipe intended to be straight.

(g) Failure to give a clean ringing sound when placed on end and dry tapped with a light hammer.

(h) Insecure attachment of branches or spurs.

34. *Tests:* The tests for pipe shall include the following:

(1) Sand-bearing crushing test.

(2) Hydrostatic test.

(3) Absorption test.

35. Tests shall be made according to the methods described in the current standard specifications of the American Society for Testing Materials for Cement Concrete Pipe, and shall meet the requirements therein. One section shall be tested for each two hundred (200) lineal feet or fraction thereof of each size to be laid, the minimum number of specimens to be tested to be six (6) for each selection of each size of pipe.

Reinforced Concrete Pipe

36. *Size and Shape:* Reinforced concrete pipe shall be made circular or egg-shape in cross-section and circular pipe made in

sizes from twenty-four (24) inches to ninety-six (96) inches inside diameter. Opposite diameters shall be true with a permissible variation of not more than three-fourths (¾) of one (1) percent. They shall be in sections not less than three (3) feet in length and ends so formed that when laid together and cemented they shall make a continuous and uniform line of pipe.

37. *Materials:* Pipe shall be made of Class A concrete and reinforcement. All materials used shall meet the requirements for the different classes of materials used as prescribed in these specifications.

38. *Forms:* All pipe shall be made in forms composed of sheet-steel cores and casings, and cast iron bottom and top rings which form the joint. The forms shall be rigidly held together and the core and casing so placed as to insure a uniform wall thickness.

39. *Air-Curing:* The top rings, core and casings shall not be removed from the pipe until the concrete has obtained its final set. Pipe shall not be lifted from the bottom rings until the concrete is from sixty (60) to seventy-two (72) hours old. After the cores and casings have been removed from the pipe, they shall be kept constantly and thoroly wetted by sprinkling with water at least three (3) times a day until they are removed from the bases and yarded. After being placed in the yard the pipe shall be sprinkled thoroly at least three (3) times a day until they are six (6) days old. Air-cured pipes are not to be laid until at least fourteen (14) days old.

40. *Steam-Curing:* Pipe may be cured by the use of wet steam in the following manner. After the pipes have been cast they shall be covered with canvas or other material, known as steaming jackets, and wet steam be turned into these jackets for one (1) day after casting. Then the casings and cores may be removed and steam again applied in the same manner for one (1) day. After this has been done the pipes may be removed from the bases and yarded, no other curing being necessary. Steam-cured pipes may be laid when they are six (6) days old.

41. *Samples for Testing:* Any or all of the following tests may be applied to samples selected by the engineer from the pipe delivered on the work. For the purpose of making such tests the contractor shall furnish and deliver, when directed, five lengths of each size pipe used in the work.

42. *Crushing Tests:* When supported at the bottom upon a knife-edge one (1) inch in width, in such a manner that an even bearing is provided thruout the whole length, exclusive of the bell, and load is applied at the crown uniformly thru a similar knife-edge, the various sizes of pipe shall withstand, without failure, the loads shown in the following table:

Diameter inches	Load Pounds per Linear Foot
24	2149
27	2369
30	2583
33	2830
36	3080
39	3300
42	3521

43. When supported on a sand saddle which extends the full length of the pipe, exclusive of the bell, and whose upper surface fits accurately the outer curved surface of the pipe, and whose width is equal to an arc of fifteen (15) degrees, in such a manner that an even bearing is provided thruout the whole length, and the load is applied at the crown uniformly thruout a knife-edge one (1) inch in width, the various sizes of pipe with diameters greater than forty-two (42) inches shall withstand the following loads:

Diameter inches	Load Pounds per Linear Foot
48	3800
54	4400
60	5000
66	5500
72	6000
78	6500
84	7000
90	7500
96	8000

44. *Absorption Test:* The specimens for absorption test shall be sound pieces with all edges broken and may be from pipes broken in the crushing test. One specimen shall be taken from each pipe broken in the crushing test or it may be taken from other pipes. They shall be from twelve (12) to twenty (20) square inches in area and shall be as nearly square as they can be readily prepared. They shall be free from observable cracks, fissures, laminations or shattered edges. These specimens after being thoroly dried and then immersed in distilled, boiling water for five (5) hours shall not absorb more than twelve (12) percent of their weight of water.

Steel Reinforcement

45. *Material:* All steel reinforcement shall consist of cold-drawn steel-wire fabric having an elastic limit of not less than fifty-five thousand (55,000) pounds per square inch; or of expanded metal having an elastic limit of not less than fifty-five thousand (55,000) pounds per square inch and expanded cold from sheets; or of reinforcing bars.

46. *Bars:* Steel bars for reinforcing shall conform to the current specifications of the American Society for Testing Materials for (A) billet steel or (B) rail steel, except that rail-steel bars may be used in sizes of one (1) inch and under only, and hot-twisted bars will not be permitted.

47. *Weights:* Dimensions of bars given on plans are based on square sections. The area and weight of bars shall not be less than ninety-five (95) percent of the values for square bars as indicated. In computing the weights of steel, one cubic inch of steel shall be regarded as two hundred and eighty-three thousandths (0.283) of a pound.

Two-Ring Segment Tile Blocks

48. *Quality:* All segment blocks shall be new and of the best quality of vitrified stone-ware, thoroly burned and true to form. They shall be made in two (2) rings so that the blocks of one (1) ring will interlock with those of the adjoining ring and the longitudinal joints of one ring will break joints with those of the other ring. The inner or wearing surface shall be evenly salt glazed and free from checks or fire cracks. All surfaces which will come in contact with the mortar in joints shall be scarified or grooved in order to secure a satisfactory bond.

49. *Thickness and Weights; Lengths:* The least allowable total thickness of material from the inside face of the sewer to the nearest opening in the block shall be one and one-half (1½) inches for sewers thirty (30) to forty-two (42) inches in diameter, one and three-fourths (1¾) inches for sewers forty-five (45) to fifty-four (54) inches in diameter and two (2) inches for sewers fifty-seven (57) to eighty-four (84) inches in diameter. The lengths of the blocks to be used on tangents shall not exceed twenty-four (24) inches and on curves twelve (12) inches. The thickness of the shell and the weight per linear foot of the sewer shall not be less than indicated in the following table:

Size Inside Diameter Inches	Thickness of Shell Inches	Weight per Linear Foot Exclusive of Mortar Pounds
30	4¾	250
33	4¾	275
36	4¾	300
39	5½	360
42	5½	390
45	6	460
48	6	490
51	6⅛	535
54	6⅛	600
57	7¼	760
60	7¼	800
63	7¼	850
66	7¼	890

Size Inside diameter Inches	Thickness of Shell Inches	Weight per Linear Foot Exclusive of Mortar Pounds
69	8¼	1040
72	8¼	1090
75	8¼	1120
78	8¼	1150
81	8¾	1250
84	8¾	1300

50. *Junctions:* Junctions for connections on segment block sewers shall be made with "T" or "Y" branches. Where the size of the branch is such as to permit, it shall be burned on the block as an integral part thereof. Where the size is such that this cannot be done, openings of the necessary size shall be left in the block, into which the necessary pipe or slant shall be inserted and tightly cemented in.

51. *Inspection Tests:* All blocks shall be satisfactory to the Engineer and subject to his inspection or rejection. If the design of the block is such as to cause the Engineer to doubt its strength for the work, the contractor may be required to make a loading test on a full size section before it is used in the work.

One-Ring Segment Tile Blocks

52. *Quality:* All blocks shall be new and of the best quality of vitrified stone ware, thoroly burned and true to form and shape. The ends shall be ship-lap jointed with abutting webs or surfaces to form a backing for mortar so as to insure tight joints on the ends of blocks. The inner or wearing surface shall be evenly salt-glazed and free from checks or fire-cracks. All surfaces which will come in contact with mortar shall be scarified or grooved in order to secure a satisfactory bond.

53. *Thickness, Weights, and Lengths:* The maximum length of block shall be twenty-four (24) inches, shorter lengths to be furnished where required for curves and specials. Blocks furnished on any one contract shall not vary more than one-fourth (¼) inch in width. The thickness of the shell and weight per linear foot of sewer shall not be less than indicated in the following table:

Size Inside Diameter Inches	Thickness of Shell Inches	Weight per Linear Foot Exclusive of Mortar Pounds
30	4¾	270
33	4¾	297
36	4¾	324
39	5½	377
42	5½	406
45	5½	435
48	6	504
51	6	555

Size Inside Diameter Inches	Thickness of Shell Inches	Weight per Linear Foot Exclusive of Mortar Pounds
54	6	592
57	6	629
60	6¾	774
63	6¾	817
66	6¾	860
69	7	900
72	7	945
78	8	1078
84	8	1176

54. *Junctions, Inspection, Tests:* The provisions of the paragraphs titled "Junctions, Inspection, Tests" of these specifications for "Two-ring segment-tile blocks" shall apply similarly to one-ring blocks.

Castings

55. *Quality:* All castings for manhole heads, covers and other purposes must be of tough gray iron free from cracks, holes, swells and cold shuts. The quality shall be such that a blow from a hammer will produce an indentation on a rectangular edge of the casting without flaking the metal.

56. *Workmanship:* All castings shall be made accurately to dimensions to be furnished and shall be planed where marked or where otherwise necessary to secure perfectly flat and true surfaces. Allowance shall be made in the patterns so that the thickness shall not be reduced.

57. No plugging, burning in or filling will be allowed. Cover must fit the frames in any position. All castings shall be carefully coated, both inside and out, with coal-tar-pitch varnish. The varnish shall be made from a good quality of coal tar, with sufficient oil added to make a smooth coating, tough and tenacious when cold, and not brittle nor with any tendency to scale off. The castings shall be evenly heated to a temperature of 300 degrees Fahrenheit immediately before being dipped, and shall possess not less than this temperature when put in the vat; they shall remain in the vat five minutes unless otherwise directed by the Engineer. The varnish shall be heated to a temperature of 300 degrees Fahrenheit, unless otherwise directed by the Engineer, and shall be maintained at this temperature during the time the casting is immersed. Fresh pitch and oil shall be added when necessary to keep the mixture at the proper consistency and the vat shall be emptied of its contents and refilled with fresh material, when considered necessary by the Engineer. After being coated the castings shall be carefully drained of all surplus varnish. No casting shall be allowed to become wet before being dipped. Any casting that is to be recoated shall first be thoroly scraped and cleaned.

Wrought Iron

58. *Quality:* All wrought iron to be used on the work shall be of the Class known as Merchant Iron Grade A, and must be free from cinder spots, injurious flaws, buckles, blisters or cracks. Wrought iron shall be made by the puddling process, or rolled from fagots or piles made from wrought iron scrap, alone or with muck bar added. All iron shall have a minimum tensile strength of fifty thousand (50,000) pounds per square inch, an elastic limit of at least twenty-five thousand (25,000) pounds per square inch. A specimen cut from the iron when nicked on one side and bent back thru an angle of one hundred eighty (180) degrees shall show a long, clean, silky fibre, free from slag, dirt or coarse crystalline spots.

59. *Finishing, Painting:* Wrought iron before leaving the factory shall be thoroly cleaned and dipped in a preparation of asphalt or coal-tar and oil as described under "Castings."

Lumber

60. Lumber shall be straight and sound, free from shakes, cracks, large or loose knots and other defects impairing its strength or durability. It shall be squared to the required dimensions thruout its entire length. Matched and grooved sheeting shall have one planed side.

Wooden Piles

61. All piling shall be sound, straight yellow pine, oak, cypress or other satisfactory timber, free from splits, shakes and all defects of a weakening nature. All piles shall be peeled and knots trimmed close to the body of the pile. The minimum diameter at point and cut-off shall not be less than that given in the following table:

Length below Cutoff Feet	Minimum Diameter at Point Inches	Minimum Diameter at Cutoff Inches
Less than 20	6	10
20-25	6	11
26-35	6	12
36-45	6	13
46 and over	6	14

Water

62. Water used for concrete or mortar shall be clean and fresh and be free from oil, acid, alkalies or organic matter.

MR. HORNER: Mr. President, I move that the report of the committee be printed and referred back to the committee for next year.

The motion was duly seconded, put and carried.

PRESIDENT NORTON: We will now have the report on Wood-Block Pavements, E. R. Dutton, Chairman.

REPORT OF THE COMMITTEE ON SPECIFICATIONS FOR WOOD BLOCK PAVING

In the 1919 meeting of the American Society for Municipal Improvements, there was a tentative specification submitted for a special pitch filler, for wood block paving. This has been used during the season of 1919 in Minneapolis work and gave promise of great success in eliminating the so-called bleeding of wood block paving. There was no difficulty with bleeding and no complaints were entered, as in previous years, because of the tracking of the sticky tar into the houses and stores and the soiling of floors, rugs, etc. This was the first season after laying and naturally it would be the worst, but we thought best to defer making a change in the specifications until the second season and see if any other unforeseen defect might show up. There has nothing of that kind developed and the pavements are almost entirely free from any tar on the surface. There was one street which we paved in 1919 which has shown bleeding and on which this special pitch filler was not used. The following analysis shows the difference between the fillers which are non-bleeding and bleeding:

	NON-BLEEDING		BLEEDING
	Hennepin Ave.	Cedar Ave.	1st Ave. S.
Spec. Grav. 38/155	1.23	1.236	1.259
Distillation			
150°	0	.2	0
170	1.2	.4	0
210	6.2	3.8	0
235	10.5	7.8	0
315	20.3	18.0	.9
355	25.4	22.5	12.8
Water	0	0	0

The theory upon which the "non-bleeding" special pitch filler was based was the use of a high-melting-point pitch cut back with a volatile solvent or oil. When used the material would flow readily into the joints and not remain on the tops of the blocks and after the volatile part had evaporated, the joints would be only partly filled with a high-melting-point pitch. By having the joints only partly filled, the expansion of the blocks would not force the pitch to the surface of the paving, as happens with the ordinary pitch filler, thereby causing the bleeding. This special pitch filler was developed for use with creosoted wood block paving laid on a smooth-top concrete with a bituminous cushion and could not have been used successfully with a sand cushion. During the stress of war times and the period of soaring high cost after the war, the creosoted wood block industry has shown some remarkable changes. Whereas before the war a large amount of wood blocks were being used in street paving at a reasonable cost and very few wood blocks were being used for floors, since the war a very large amount of wood blocks are being used for factory and other flooring at a high cost and a very small amount is being used in street paving because of its high cost, altho other classes of street paving have increased in cost as much as, if not more than, wood blocks. Even at the high cost of wood block paving, there is no question but that it is the cheapest and best in the long run. The following specification, following the lines outlined above, is submitted as an addition to or change of the specifications as adopted by the American Society for Municipal Improvements, at the meeting in 1916 as subsequently amended, and should be inserted immediately after Section "4" Subdivision "b—Asphalt filler" as it appears on page 596 of the proceedings as officially published, and on page 11 of the separate 1917 edition of the "Specifications for Creosoted Wood Block Paving," adopted Oct. 13, 1916.

Page 11, Insert immediately after Section 4, subdivision B—Asphalt Filler, the following:

c—*Special Pitch Filler.*

NOTE: To be used only where bituminous cushion is used.

The filler shall be made from the products obtained from the distillation of coal-tar only, no admixtures of other materials will be permitted, and it shall comply with the following requirements and tests made as indicated:

1. The filler shall contain no water.

2. Its specific gravity at 15.5° C. (60° F.) shall be not less than 1.20 nor more than 1.23.

3. *Distillation.* When distilled as below required it shall show percentage distilled by volume as follows:
From 0 to 1% at 100° C. (212° F.)
From 1 to 10% at 170° C. (338° F.)
From 20 to 40% at 355° C. (671° F.)

4. The specific gravity of the distillate at 15.5° C. (60° F.) shall be from 0.950 to 1.03.

5. The melting point of the residue by the air-bath ½-inch-cube method shall be from 117.8° C. (244° F.) to 126.7° C. (260° F.).

(Tests to be made according to methods recommended by the Committee on Standard Tests for Bituminous Materials of the American Society for Municipal Improvements.)

The changes above given were adopted by letter ballot of the members by votes of 15 for to 1 against, as shown by the report of the Canvassing Committee on page 406.

PRESIDENT NORTON: Gentlemen, you have heard the report of the Committee and it is now before the convention.

MR. DUTTON: There may be some question in regard to the part that refers to the standardized method of testing.

MR. BLANCHARD: The simplest way would be to eliminate that from the report.

MR. DUTTON: It would be satisfactory to eliminate the method of test.

PRESIDENT NORTON: The Committee amends its report. Does the chairman wish to move that it be referred to letter ballot?

MR. DUTTON: I move that it be referred to letter ballot.

The motion was duly seconded, put and carried.

PRESIDENT NORTON: We will now call upon the Committee on Brick Pavements for the revised report.

REPORT OF COMMITTEE ON SPECIFICATIONS FOR BRICK PAVING

We hereby submit the following additions and changes to the present specifications. Your committee has very carefully reviewed the present specifications item by item. Numerous revisions have been suggested, and these revisions discussed by your committee, interested parties appearing before it. It is, however, the unanimous opinion of the committee that, with the exception of the aforesaid additions and changes, the present specifications should remain as adopted in 1918.

We wish to call attention that under Part 2, Section 11, the plan of the template, which is supposed to accompany these specifications, is not shown. We recommend that the same should be printed under Section 11.

Respectfully submitted,
E. H. CHRIST, *Chairman*
F. J. CELLARIUS
R. B. LEE
S. CAMERON CARSON
GEO. F. FISK
Committee

[NOTE: The edition of the specifications referred to in the following is that adopted Oct. 3, 1918.]

Under Part 2, Page 5, add a new paragraph 7½, as follows:

SUB-GRADE UNDER-DRAINAGE

Adequate under-drainage shall be provided to remove rapidly all water from the sub-grade of the roadway, as provided in the Specifications for Sidewalks and Curbs of the American Society for Municipal Improvements. Where required a similar cross-drain shall also be provided.

Add to Part 2, Section 8, after "a frozen sub-grade," on page 7:

All castings for man-holes, catch-basins, etc., shall not be imbedded in the concrete foundation. They shall be made to rest on top of the foundation to allow the pavement to expand uniformly, therefore avoiding the cracking and crushing of the brick.

Add to Part 2, Section 13, after "of the brick laying" on page 8:

When properly graded sand cannot be obtained for cushion, the following cushion may be used. The sand and cement in proportion of one part cement to four parts sand and shall be thoroly mixed dry in a small batch mixer until it is of uniform color thruout. The mixture shall then be spread on the prepared foundation to a depth of 1 inch and shaped with a template to a true cross-section parallel to and 4 inches below the cross-section of the finished pavement. Brick shall be laid, rolled and culled immediately following the placing of the sand-cement cushion. After the culling is effected, they shall then be well wet down and grouted as hereinafter specified in Section 18 A of these Specifications.

In Part 2, Section 16, page 9, change the fifth line of the second paragraph, reading "three-quarters (¾) of an inch in width" to read: "*one* (*1*) *inch* in width."

In Part 2, page 13, strike out Section 18 C and insert the following:

SPECIFICATIONS FOR ASPHALT FILLER

(To be applied by the squeegee method)

18 C. *General:*

The asphalt filler shall be homogeneous, free from water and shall not foam when heated to 200 deg. C. (392 deg. F.). It shall meet the following requirements:

Physical and Chemical Properties:

1. Flash Point not less than 200 deg. C. (392 deg. F.).

2. Melting Point (Ring and Ball) 65 deg. C. (149 deg. F.) to 100 deg. C. (212 deg. F.).

3. Penetration at 25 deg. C. (77 deg. F.), 100g., 5 sec. 30 to 40 or 40 to 50.

Penetration at 0° C. (32 deg. F.), 200g., 1 min., not less than 10.

4. Ductility at 25 deg. C. (77 deg. F.) not less than 2.

5. Loss at 163 deg. C. (325 deg. F.), 5 hrs., not more than 3%.

6. Total bitumen (soluble in carbon disulphide) not less than 95%.

7. Per cent of total bitumen soluble in carbon tetrachloride not less than 95%.

[NOTE: *The exact penetration limits should be inserted by the engineer with a 10-point limit. It is suggested that for low-temperature conditions a penetration of from 40 to 50 be specified and for high-temperature conditions a penetration of from 30 to 40 be specified.*]

Sample—A one-pound sample of the asphalt filler that the contractor proposes to use in his work must be handed in with his bid. No asphalt filler other than that specified in his bid shall be used by any contractor except with the written consent of the engineer and provided that the filler used shall comply in all respects with these specifications.

Methods of Testing—Standard methods of testing adopted by the American Society for Municipal Improvements and, in addition, the test for Bitumen as described in the United States Department of Agriculture, Bulletin 314, Page 25.

In Part 2, Section 19, page 14, strike out NOTE 1.

The changes above given were adopted by letter ballot of the members by votes varying from 14 for to 5 against to 19 for and none against, as shown by the report of the Canvassing Committee on page 406.

MR. CHRIST: I move the changes be referred to letter ballot.

The motion was duly seconded, put and carried.

PRESIDENT NORTON: The next upon the program is the report of the Committee on Sidewalks and Curbs, S. Sammelman, Chairman.

MR. SAMMELMAN: I wish to call attention to the fact that we have a one hundred per cent attendance of this committee at this Convention. I think that should not altogether pass without notice because it is more or less unusual.

As you know, my time has been very much occupied in arranging for the Convention itself, so that I really must apologize for not giving as much time to the Committee itself as I should have given. However we have a most excellent report for you. The credit for this is due the other members of the Committee. I will ask Mr. Babcock to read the report to you. As you will recall, last year we submitted to you the recommendation that the standard specifications for sidewalks, adopted by the American Concrete Association be adopted by this Society. I believe the Secretary has ruled that this permits the recommendation to be voted upon today. I would ask that a vote be had today. I would suggest that the specifications on curb go to ballot.

Our main object in preparing the specifications on curbs has been to standardize curb, if possible. Unless some one of you has studied the situation, you probably do not realize the diversity of opinion on curb. We received specifications from about fifty cities, and nearly every one was different.

With your permission, I will call upon Mr. Babcock from Buffalo to read our report.

Mr. Babcock read report of Committee on Specifications for Sidewalks and Curbs as given below.

MR. BABCOCK: I move that the specifications prepared by the Committee be received and referred to letter ballot.

The motion was duly seconded, put and carried.

MR. SAMMELMAN: Before we pass, would it not be well for the Society to adopt recommendations in regard to the sidewalk specifications. Our recommendations last year and this year also are that the specifications adopted by the American Concrete Institute be adopted by this society.

PRESIDENT NORTON: The chair rules that they are also a part of the specifications of this Society and should be referred to letter ballot.

MR. SAMMELMAN: The reason I suggest that is because it would save the society expense. The sidewalk specifications are rather lengthy and were printed in last year's proceedings. I believe the Society can adopt them now.

SECRETARY BROWN: They will have to go to letter ballot.

PRESIDENT NORTON: I do not believe it will be necessary to print them, but refer them to letter ballot.

WALTER G. KIRKPATRICK (by letter): Illness prevents my attending the St. Louis Convention. If it is not too late, please note the following comment on the Report of the Committee on Standard Specifications for Sidewalks and Curbs, Proceedings for 1919, page 633.

It would be a mistake to omit from the standard specifications all reference to and specifications for concrete combined curb and gutter, which have been used successfully and economically by many cities and towns. While granite is superior to concrete for curb, the cost of granite in a large number of places is prohibitive. Concrete curb must be largely used and its field of usefulness is greatly enlarged by molding in place the curb combined with concrete gutter of proper width. If the gutter portion fails first, this is probably due to inferior workmanship, to plastering on an unbonded surfacing. Counting all the items of cost of the pre-cast reinforced six-foot curb in place, as recommended by the committee, but not including the cost of the separate gutter required for it, this cost will in many or all cases exceed the cost of the combined curb and gutter. Even if in some slabs the gutter portion fails first, the whole of these is easily and cheaply replaced. On many streets in residence and light traffic districts, on macadamized and graveled streets, totaling more miles than all other streets, no other gutter is as cheap and satisfactory. Wherever used, the broad base of the combined curb and gutter assures strength, good alinement, good appearance, no resetting, good waterway, in fact a good frame around the picture.

REPORT OF THE COMMITTEE ON SPECIFICATIONS FOR SIDEWALKS AND CURBS

Your Committee recommends adoption of the specifications for Concrete Sidewalks, being those printed on page 624 of our A. S. M. I. Proceedings of 1919, and adopted by the American Concrete Institute.

Your committee has compared specifications for curb from upward of 50 towns. It has also consulted with the Quarry operators as to practicable or economical sizes, and definitions of dressing.

In general, we would not recommend the manner of dressing curb, but would specify the result desired. We find that the terms "hammer, crandall, 4-cut" etc. suggest local habit, and we advise the standard methods employed by the operators in their several fields.

We would indicate a method for setting in concrete. If not set in concrete the local engineer may best determine the requirements of his case.

We would make provision for use of drain tile.

If a test be required, we recommend use of the standard brick rattler as described in our proceedings of 1914, page 524, for determining abrasion; for the reason that it may now be installed in many cities; or the tests for French coefficient of wear, for hardness and toughness as set forth in Bulletin 347 Department of Agriculture 1916.

Your committee is now endeavoring to co-ordinate the rattler test with the Deval test for coefficient of wear so that later on the results may be referred to in terms of either method with reasonable intelligence. We hope also to obtain results of breaking tests.

In 1919, concrete curb cast in place, and combined curb and gutter, were not recommended, but owing to dependence on concrete in certain localities, we present specifications which we believe should be used for this character of work.

We make a few changes in the text for premolded reinforced concrete curb, pages 634 and 635 proceedings of 1919, which, however, do not change the intent or essentials, and offer the following specifications.

S. SAMMELMAN, *Chairman*
MONROE L. PATZIG
H. A. ROWLAND
C. P. BABCOCK
T. E. COLLINS

SPECIFICATIONS FOR CONCRETE SIDEWALKS

These specifications apply to concrete sidewalks in residence and business districts, and cover the preparation of the sub-base, the laying and finishing of the walk and its protection during early hardening.

GENERAL REQUIREMENTS

Materials

1. *Cement.*—The cement shall meet the requirements of the current Standard Specifications for Portland Cement of the American Society for Testing Materials.

2. *Aggregate.*—Before delivery on the job, the contractor shall submit to the architect or engineer a fifty (50)-lb. sample of each of the aggregates proposed for use. These samples shall be tested and if found to pass the requirements of the specifications, similar material shall be considered as acceptable for the work. In no case shall aggregate containing frost or lumps of frozen material be used.

(a) *Fine Aggregate.*—Fine aggregate shall consist of natural sand or screenings from hard, tough crushed rock or gravel consisting of quartz grains or other hard material, clean and free from any surface film or coating and graded from fine, coarse particles predominating. Fine aggregate, when dry, shall pass a screen having four (4) meshes to the linear inch; not more than twenty-five (25) per cent shall pass a sieve having fifty (50) meshes per linear inch, and not more than five (5) per cent shall pass a sieve having one hundred (100) meshes per linear inch. Fine aggregate shall not contain injurious vegetable or other organic matter as determined by the colorimetric test nor more than five (5) per cent by volume of clay or loam. Field tests may be made by the architect or engineer on fine aggregate as delivered at any time during progress of the work. If there is more than seven (7) per cent of clay or loam, by volume, in one (1) hour's settlement after shaking in one hundred (100) per cent of water, the material represented by the sample shall be rejected.

Fine aggregate shall be of such quality that mortar composed of one (1) part portland cement and three (3) parts fine aggregate, by weight, when made into briquets or cylinders, shall show a tensile or compressive strength, at seven (7) and twenty-eight (28) days, at least equal to the strength of briquets or cylinders composed of one (1) part of the same cement and three (3) parts standard Ottawa sand by weight. The percentage of water used in making the test specimens of cement and fine aggregate shall be such as to produce a mortar of the same consistency as that of the Ottawa sand test specimens of standard consistency. In other respects all briquets or cylinders shall be made in accordance with the methods of testing cement recommended by the American Society for Testing Materials. (See Cement Specifications, A.S.T.M.)

(b) *Coarse Aggregate.*—Coarse aggregate shall consist of clean durable crushed rock, pebbles or crushed blast furnace slag, graded in size, free from vegetable or other organic matter, and shall contain no soft, flat or elongated particles. The slag shall not contain more than one and one-half (1½) per cent of sulphur as sulphides. The size of the coarse aggregate shall range from one (1) inch down, not more than five (5) per cent passing a screen having four (4) meshes per linear inch, and no intermediate sizes shall be removed.

(c) No. 1 *Aggregate for Wearing Course.*—No. 1 aggregate for the wearing course shall consist of clean, hard, tough, crushed rock or pebbles, free from vegetable or other organic matter and shall contain no soft, flat or elongated particles. It shall pass, when dry, a screen having one-half (½) inch square openings, and not more than ten (10) per cent shall pass a screen having four (4) meshes per linear inch.

3. *Mixed Aggregate.*—Crusher-run stone, bank-run gravel or mixtures of fine and coarse aggregate prepared before delivery on the work shall not be used.

4. *Sub-Base.*—Only clean, durable material, such as coarse gravel or steam-boiler cinders free from ash or particles of unburned coal shall be used in the sub-base. (Note.—Eliminate this clause unless sub-base is required.)

5. *Water.*—Water shall be clean, free from oil, acid, alkali, vegetable or other organic matter.

6. *Color.*—If artificial coloring material is required only those mineral colors shall be used which, in the amount hereinafter specified, will not appreciably impair the strength of the cement.

7. *Reinforcement.*—The reinforcing metal shall meet the requirements of the current Standard Specifications for Steel Reinforcement of the American Society for Testing Materials. It shall be free from excessive rust, scale, paint or coating of any character which will tend to reduce or destroy the bond. The reinforcement shall have a weight of not less than twenty-eight (28) lb. per one hundred (100) square feet.

8. *Joint Filler.*—The joint filler shall be a suitable elastic waterproof compound that will not become soft and run out in hot weather, nor hard and brittle and chip out in cold weather, or prepared strips of fiber matrix and bitumen as approved by the architect or engineer. The strips shall be one-half (½) inch in thickness, their width shall at least equal the full thickness of the slab and their length shall at least equal the width of the slab at the joint.

Sub-grade

9. *Preparation.*—All soft and spongy places shall be removed and all depressions filled with suitable material which shall be thoroly compacted in layers not exceeding six (6) inches in thickness. The sub-grade shall be thoroly tamped until it is brought to a firm, unyielding surface. It shall have a slope toward the street curb of not less than one-half (½) inch per foot.

When the concrete sidewalk is to be constructed over an old path composed of gravel or cinders, the old path shall be entirely loosened, the material spread for the full width of the subgrade and compacted as specified.

10. *Deep Fills.*—All fills shall be made in a manner satisfactory to the architect or engineer. The use of muck, quicksand, soft clay, spongy or perishable material is prohibited. The top of all fills shall extend beyond the walk on each side at least one

(1) foot, and the sides shall have a slope greater than one (1) on one and one-half (1½).

11. *Drainage.*—When required, a suitable drainage system shall be installed and connected with sewers or other drains indicated by the architect or engineer.

12. *Depth.*—The subgrade shall be not less than ———— (——) in. below the finished surface of the walk.

Note.—Subgrade to be at least five (5) inches below the finished surface of the walk when sub-base is not required and at least eleven (11) inches below when sub-base is required.

Sub-base

(Omit these sections unless sub-base is required.)

13. *Thickness.*—On the sub-grade shall be spread a material as hereinbefore specified which shall be thoroly rolled or tamped to a surface at least ———— (——) inches below the finished grade of the walk. On fills, the sub-base shall have the same slope as the sides of the fill.

14. *Wetting.*—While compacting the sub-base, the material shall be kept thoroly wet, and shall be wet when the concrete is deposited but shall show no pools of water.

Forms

15. *Materials.*—Forms shall be free from warp and of sufficient strength to resist springing out of shape.

16. *Setting.*—The forms shall be well staked or otherwise held to the established lines and grades and their upper edges shall conform to the established grade of the walk.

17. *Division Plates.*—Suitable metal division plates shall be provided to completely separate adjacent slabs during construction unless otherwise permitted by the architect or engineer.

18. *Treatment.*—All wood forms shall be thoroly wetted and metal forms oiled or coated with soft soap or whitewash before depositing any material against them. All mortar and dirt shall be removed from forms that have been previously used.

Construction

19. *Size of Slabs.*—The slabs or independently divided blocks when not reinforced shall have an area of not more than one hundred (100) square feet, and shall not have dimensions greater than ten (10) feet, nor shall the length of any such slab be greater than one and one-half (1½) times the width. Larger slabs shall be reinforced as hereinafter specified.

20. *Thickness of Walk.*—The thickness of the walk shall not be less than ———— (——) inches.

Note.—Walks for residence districts to be at least five (5) inches thick and for business districts six (6) inches. Where walks cross driveways in residence districts, the total thickness shall be increased to six (6) inches with a one (1) inch wearing course.

21. *Joints.*—A one-half (½)-inch joint shall be provided at least once every fifty (50) feet in the length of the walk, which shall be filled with suitable material as specified under "Joint Filler." A similar joint shall be provided at each intersection of sidewalk and street curb and at such other points as may be designated by the architect or engineer. Sidewalks in business districts shall be separated from abutting buildings by a one-half (½)-inch joint.

22. *Protection of Edges.*—Where required by the architect or engineer, the edges of the slabs at the joints shall be protected by metal. Unless protected by metal, the upper edges of the slabs shall be rounded to a radius of one-half (½) inch. The edges of all slabs abutting a business street which act as curbing must be protected by suitable metal angles or corner-bars as approved by the architect or engineer.

Measuring and Mixing

23. *Measuring.*—The method of measuring the materials for the concrete or mortar, including water, shall be one which will insure separate and uniform proportions of each of the materials at all times. A sack of portland cement (94 lb. net) shall be considered one (1) cu. ft.

24. *Machine Mixing.*—All concrete shall be mixed by machine except when the architect or engineer shall otherwise permit under special conditions. A batch mixer of any approved type shall be used. The ingredients of the concrete or mortar shall be mixed to the specified consistency, and the mixing shall continue for at least one (1) minute after all materials are in the drum. The drum shall be completely emptied before receiving material for the succeeding batch.

25. *Hand Mixing.*—When it is necessary to mix by hand, the materials shall be mixed dry on a water-tight platform until the mixture is of uniform color, the required amount of water added, and the mixing continued until the mass is of proper consistency and homogeneous.

26. *Retempering.*—Retempering of mortar or concrete which has partially hardened, that is, remixing with or without additional materials or water, shall not be permitted.

Protection

27. *Treatment.*—As soon as the finished walk has hardened sufficiently to prevent damage, the surface of the walk shall be sprinkled with clean water or preferably covered with at least one (1) inch of wet sand or earth and kept wet for at least seven (7) days.

28. *Protection.*—The freshly finished walk shall be protected from hot sun and drying winds until it can be sprinkled and covered as above specified. The concrete surface must not be damaged or pitted by rain drops, and the contractor shall provide and use, when necessary, sufficient tarpaulins to completely cover all sections that have been placed within the preceding twelve (12) hours. The contractor shall erect and maintain suitable barriers to protect the walk from traffic and any section damaged from traffic or other causes occurring prior to its official acceptance, shall be repaired or replaced by the contractor at his own expense in a manner satisfactory to the architect or engineer. Before the sidewalk is opened to traffic the covering shall be removed and disposed of by the contractor. The walk shall not be opened to traffic until the architect or engineer so directs.

29. *Temperature Below 35 Degrees Fahrenheit.*—If at any time during the progress of the work the temperature is, or in the opinion of the architect or engineer will, within twenty-four (24) hours, drop to 35 degrees Fahrenheit, the water and aggregates shall be heated and precautions taken to protect the work from freezing for at least five (5) days.

30. *Name Stamp.*—The contractor shall mark in the walk at each end of every one hundred fifty (150) feet of walk or fraction thereof, either by stamping or by inlaying an approved metal plate, his name and the year in which the walk is constructed. The stamped letters shall be one (1) inch high and one-fourth (¼) inch deep. If a metal plate is used, the top of the plate shall be flush with the top of the walk.

TWO-COURSE SIDEWALK

For two-course walks the following will apply in addition to the general requirements:

Concrete Base

31. *Proportions.*—The concrete shall be mixed in the proportions by volume of one (1) sack of portland cement, two and one-half (2½) cu. ft. of fine aggregate and five (5) cu. ft. of coarse aggregate.

32. *Consistency.*—The materials shall be mixed wet enough to produce a concrete of consistency that will flush readily under slight tamping, but which can be handled without causing a separation of the coarse aggregate from the mortar.

33. *Placing.*—After mixing, the concrete shall be handled rapidly and the successive batches deposited in a continuous operation completing individual sections to the required depth and width. Under no circumstances shall concrete that has partly hardened be used. The forms shall be filled and the concrete struck off and tamped to a surface the thickness of the wearing course below the established grade of the walk. The method of placing the various sections shall be such as to produce a

straight clean-cut joint between them so as to make each section an independent unit. If dirt, sand or dust collects on the base it shall be removed before the wearing course is applied. Workmen shall not be permitted to walk on the freshly-laid concrete. Any concrete in excess of that needed to complete a section at the stopping of work shall not be used. In no case shall concrete be deposited upon a frozen sub-grade or sub-base.

34. *Reinforcing.*—Slabs having an area of more than one hundred (100) sq. ft., or having dimensions greater than ten (10) ft., shall be reinforced with wire fabric or with plain or re-formed bars. The reinforcement shall be placed upon and slightly pressed into the concrete base immediately after the base is placed. It shall not cross joints and shall be lapped sufficiently to develop the full strength of the metal. The reinforcement shall not be less than one (1) inch from the finished surface of the walk.

Wearing Course

35. *Proportions for Mixture No. 1.*—The wearing course shall be mixed in the proportions of one (1) sack of portland cement and two (2) cu. ft. of fine aggregate. The minimum thickness shall be three-quarters ($\frac{3}{4}$) inch. (Note.—Proportions and thickness for residence districts or where traffic is light.)

36. *Proportions for Mixture No. 2.*—The wearing course shall be mixed in the proportions of one (1) sack of portland cement, one (1) cu. ft. of fine aggregate and one (1) cu. ft. of No. 1 aggregate for wearing course. The minimum thickness shall be one (1) inch. (Note.—Proportions and thickness for business districts or where traffic is heavy.)

37. *Consistency.*—The mortar shall be the dryest consistency possible to work with a sawing motion of the strike-board.

38. *Placing.*—The wearing course shall be placed immediately after mixing. It shall be deposited on the fresh concrete of the base before the latter has appreciably hardened, and brought to the established grade with a strike-board. In no case shall more than forty-five (45) minutes elapse between the time the concrete for the base is mixed and the wearing course is placed.

39. *Finishing.*—After the wearing course has been brought to the established grade by means of a strike-board, it shall be worked with a wood float in a manner which will thoroly compact it and provide a surface free from depressions or irregularities of any kind. When required, the surface shall be steel-troweled, but excessive working shall be avoided. In no case shall dry cement or a mixture of dry cement and sand be sprinkled on the surface to absorb moisture or to hasten hardening. When division plates are not used, the slab markings shall be made in the wearing course directly over the joints in the base with a tool which will completely separate the wearing course of adjacent slabs.

Unless protected by metal the surface edges of all slabs shall be rounded to a radius of one-half (½) inch.

40. *Coloring.*—If artificial coloring is used, it must be incorporated with the entire wearing course, and shall be mixed dry with the cement and aggregate until the mixture is of uniform color. In no case shall the amount of coloring exceed five (5) per cent of the weight of the cement.

ONE-COURSE SIDEWALK

For one-course walks the following will apply in addition to the general requirements.

41. *Proportions.*—The concrete shall be mixed in the proportions of one (1) sack of portland cement to not more than two (2) cu. ft. of fine aggregate and not more than three (3) cu. ft. of coarse aggregate and in no case shall the volume of the fine aggregate be less than one-half (½) the volume of the coarse aggregate.

A cubic yard of concrete in place shall contain not less than six and eight-tenths (6.8) cu. ft. of cement.

42. *Consistency.*—The materials shall be mixed with sufficient water to produce a concrete which will hold its shape when struck off with a strike-board. The consistency shall not be such as to cause a separation of the coarse aggregate from the mortar in handling.

43. *Placing.*—After mixing, the concrete shall be handled rapidly and the successive batches deposited in a continuous operation completing individual sections to the required depth and width. Under no circumstances shall concrete that has partly hardened be used. The forms shall be filled and the concrete brought by means of a strike-board to a surface one-quarter (¼) inch above the established grade (to allow for compacting by roller in finishing). The method of placing the various sections shall be such as to produce a straight clean-cut joint between them so as to make each section an independent unit. Any concrete in excess of that needed to complete a section at the stopping of work shall not be used. Workmen shall not be permitted to walk on the freshly-laid concrete. In no case shall concrete be deposited upon a frozen sub-grade or sub-base.

44. *Reinforcing.*—Slabs having an area of more than one hundred (100) sq. ft., or having dimensions greater than ten (10) ft., shall be reinforced with wire fabric or with plain or deformed bars. The reinforcement shall be placed two (2) inches below the finished surface of the walk. The reinforcement shall not cross joints and shall be lapped sufficiently to develop the full strength of the metal.

45. *Finishing.*—After the concrete has been brought by means of a strike-board to a surface one-quarter (¼) inch above the established grade, it shall be rolled transversely with a metal

roller having a smooth even surface approximately 3 ft. in length, and from 6 to 8 inches in diameter, and weighing not more than 50 lb. The rolling must be done from the side, or in such a manner that the surplus water is displaced from the surface of the concrete. The rolling must be continued at intervals of 15 to 40 minutes until all excess water is removed.

Unless protected by metal the surface edges of all slabs shall be rounded to a radius of one-half (½) inch.

(Cross out the following sections except for the surface desired.)

(a) *Smooth Surface.*—Following the rolling above described the surface of the concrete shall be troweled with a steel trowel to a smooth even surface free from depressions or irregularities of any kind. Excessive working of the surface with the trowel shall be avoided.

(b) *Medium Rough Surface.*—Following the rolling above described the surface shall be floated with a wooden float only, producing an even, gritty finish. On wide sidewalks after rolling, the finishing may be done with two applications of a canvas belt, not less than 6 inches wide, and about 2 feet longer than the width of the sidewalk. For the first application, the belt shall be drawn across the surface with vigorous strokes at least 12 inches long, and moved ahead very slightly at each stroke. The second application shall be given immediately after the water glaze or sheen disappears, and the stroke of the belt shall be not more than 4 inches, while the longitudinal motion shall be greater than during the first application.

(c) *Rough Surface.*—Following the rolling above described, the surface shall be floated with a wooden float leveling all sags and producing an even surface. After being floated in this manner the roughening shall be done by slapping the surface of the concrete with the face of the float, raising the float vertically from the concrete after each stroke.

SPECIFICATIONS FOR CURBS

THE TEST OR QUALIFICATION OF CURB STONE

If a test is desired it shall be provided for in the local specifications.

1. *Abrasion.* The loss by abrasion shall be determined by the "Rattler Test" specified in pages 524–531 of the A.S.M.I. 1914 Proceedings, for Brick.

The rattler, abrasive charge, the test and record shall be as described therein. Four blocks of the material to be tested shall be axed or hammered to about 5x6x10 inches and dried (these 4 blocks will weigh from 110 to 120 pounds, approximating the weight of 10 brick).

For the present, a loss of 12 per cent by abrasion will be permissible.

If made thru the "Deval Abrasion Test" as described in Bulletin 347 U. S. Dept. of Agriculture, March 1916, a co-efficient of wear of seven (7) is permissible.

2. *Absorption.*—The dry blocks shall be weighed, then immersed in water for 48 hours, drained off for 5 minutes and then weighed. The increase in weight is the absorption and should not exceed 2½ per cent.

SETTING CURB

3. *Grading.*—Curb shall not be set until the rough grade has been prepared and rolled, if the latter is specified.

4. *Temperature.*—Curb shall not be laid in concrete when there is indication of freezing. If overtaken by temperature falling to 35 degrees F., the concrete in place shall be covered with dirt from the street or otherwise protected as the engineer directs.

For Setting Curb in Concrete

5. *Curb Trench.*—The curb trench should be 18 inches wide, 6 inches in front of the curb and 12 inches back from face of curb. It should be at least 22 inches deep. If the back of the trench suggests caving in, it should be held with planks so as to insure the full width of concrete thruout its depth, with square shoulder at the top.

6. *Concrete.*—Shall be made with portland cement, aggregates and water, conforming to those specified for paving base, except that the coarse aggregate should pass a 1-inch mesh. These are mixed in the proportion of one (1) part of cement to three (3) of fine and seven (7) of the coarse aggregate.

Should a gravel carrying adequate sand be used, the engineer shall specify the more exact proportions according to run of material and the details for mixing.

The concrete shall be spread in the bed not more than ten (10) feet in advance of placing the curb.

As soon as the curb is bedded to its true line and grade, the trench should be filled with the concrete in front of the curb to the bottom of the paving base and back of the curb to within 6 inches of the top of the curb. A light tamping or spading is advisable, but the curb must not be disturbed. The remainder of the trench back of the curb shall be filled with dirt from the the street or with a specified material.

7. *Drain Tile.*—If drain tile is required, the bottom of the trench should be 36 inches below the top of the curb, and at least six (6) inches wide.

The tile should be a commercial size, not less than 3 or 4 inches inside diameter. It shall be laid to line and grade and connected by vitrified tile, closed joint, to sewers or catch-basins.

If outlet is available it is best to make these connections about 300 feet apart. The tile shall be covered with screened gravel or broken stone, none of which shall pass a ½-inch screen (the coarse aggregate for concrete may be used). This covering shall be carried up to the bottom of the curb trench, thus it will be 14 inches deep.

8. *If Not Set in Concrete.*—If the curb is not set in concrete, the trench and drain tile should be as above.

9. *Drain Tile Not Used.*—If, however, drain tile is not required, the curb trench may be of such depth and may be drained off as local conditions suggest.

[NOTE: In the trench described above about 1.3 to 1.5 cubic feet of concrete will be required for one (1) linear foot of curb.]

DRESSING OR CUTTING

10. The face shall be dressed to vary not more than ⅜ inch from a plane surface, for a depth of 12 inches from the top. The remainder of the face shall be free from projections of more than ½ inch.

The back shall likewise be dressed parallel to the face for a depth of 1 inch from the top. The remainder of the back shall be free from projections of more than 1 inch.

The top shall likewise be dressed having a bevel or rise of ¼ inch from face to back of curb.

The ends shall likewise be dressed at right angles to the face and top to vary not more than ⅛ inch from a plane surface for a depth of 12 inches from the top.

11. *Circular Curb* for round corners and closures should meet the above except as to length.

12. *Bull Nose* or round edge curb are regarded as special features and entail extra cutting to meet local practice.

13. *Headers or Protection* curb shall be dressed to a plane surface on top, ends cut at right angles to the face and top to a ⅜-inch joint for a depth of 8 inches.

[NOTE: Except for special purposes the standard methods of dressing or cutting as employed for the several kinds of stone are regarded as acceptable. Unnecessary cost is incurred by specifying a particular method.]

GRANITE CURB

The curb shall be straight split, medium grained, of uniform texture and color, free from seams, excess of mica and disintegration.

14. *If Set in Concrete* the following dimensions are recommended:

The granite splits more readily into shapes where the depth is three times the width:

Length not less than four (4) feet.

Top Width 5 inches or as required, having in mind the quarrying proportion of one-third the depth.

Bottom Width should be not less than three (3) inches rough squared.

Depth—For not less than three-fourths of the length, the depth should be 16 inches for a curb 5 inches wide.

15. *If Not Set in Concrete* a special depth up to 20 or 26 inches may be required.

HARD SANDSTONE

16. The curb shall be of best quality hard sandstone, uniform color, free from seams and laminations.

17. *If Set in Concrete* the following dimensions are recommended:

Length not less than 36 inches nor more than 42 inches.

Top width 4, 5 or 6 inches, as required.

Bottom width should be not less than one-half the width specified for the top.

Depth—For not less than three-fourths of the length, the depth should be 16 or 18 inches for the five- or six-inch width respectively.

18. *If Not Set in Concrete* a special depth up to 20 or 25 inches may be required.

BLUESTONE AND HARD LIMESTONE

19. Same as for Hard Sandstone, except that the length may be from 36 to 48 inches.

SOFT SANDSTONE AND LIMESTONE

20. As the softer stone are often machine-cut or sawed, the dimensions need not be limited by strata or natural cleavage, but for handling and laying they should, if set in concrete, have a length not less than 4 feet nor more than 6 feet.

Top width 5 or 6 inches.

Bottom width same as top.

Depth—For a length not less than three-fourths of the top length, the depth should be 16 or 18 inches for a 5- or 6-inch width respectively.

If Not Set in Concrete a depth up to 24 inches may be required.

21. *Header or Protection Curb* should have a depth of 12 to 14 inches, a width not less than 4 inches and length not less than 24 inches.

It shall be set in a concrete bed 6 inches deep and 18 inches wide and backed with concrete to within 8 inches of its top on the paving side and flush with the top on the unpaved or exposed side.

SPECIFICATIONS FOR CONCRETE CURB

22. *Dimensions.*—Standard cross-section for straight curb shall be 5 inches in thickness and 18 inches in depth. The top corner on face of curb shall be rounded to a radius of one inch.

23. *Proportions.*—The curb shall be made of portland cement concrete in either of the following proportions. 1 part (by volume) of portland cement to 3 parts (by volume) of mixed aggregate, or 1 part portland cement, to 2 parts fine aggregate, to 4 parts coarse aggregate.

Materials

24.—*The cement* shall meet the requirements of the current standard specifications for portland cement of the American Society for Testing Materials.

25. *Mixed Aggregate* shall consist of natural sand, gravel or screenings from hard, tough, crushed rock or gravel, consisting of quartz grains or other hard material, clean and free from any surface film or coating and graded from fine to coarse, the latter particles predominating. Mixed aggregate, when dry, shall pass a screen having ¾-inch circular openings; not more than 20 per cent shall pass a sieve having fifty (50) meshes per linear inch, and not more than 5 per cent shall pass a sieve having one hundred (100) meshes per linear inch. It shall not contain injurious vegetable or other organic matter as determined by the colorimetric test nor more than five (5) per cent, by volume, of clay or loam.

That portion of the mixed aggregate which passes the ten-(10) mesh-per-linear-inch screen shall be of such quality that the mortar composed of one (1) part portland cement and three (3) parts aggregate to be tested, by weight, when made into briquets or cylinders, shall show tensile and compressive strength, at seven (7) and twenty-eight (28) days, at least equal to the strength of briquets or cylinders composed of one (1) part of the same cement and three (3) parts standard Ottawa sand by weight. The percentage of water used in making the test specimens of cement and aggregate to be tested shall be such as to produce a mortar of the same consistency as that of the Ottawa sand test specimens of standard consistency. In other respects all briquets or cylinders shall be made in accordance with the methods of testing cement recommended by the American Society for Testing Materials (See Cement Specifications, A.S.T.M.).

26. *Fine Aggregate* shall consist of natural sand or screenings from hard, tough crushed rock or gravel consisting of quartz grains or other hard materials, clean and free from any surface film or coating and grading from fine to coarse, the latter particles

predominating. Fine aggregate shall meet all the requirements for mixed aggregate, except as to size, which are as follows: all of it shall pass a screen having four (4) meshes to the linear inch; not more than twenty-five (25) per cent shall pass a sieve having fifty (50) meshes per linear inch and not more than 5 per cent shall pass a sieve having 100 meshes per linear inch.

27. *Coarse Aggregate* shall consist of clean durable crushed rock, or pebbles, graded in size, free from vegetable or other organic matter, and shall contain no soft, flat or elongated particles. The size of the aggregate shall range from that passing thru a ¾-inch circular opening, to not more than five (5) per cent passing a screen having four (4) meshes per linear inch, and no intermediate sizes shall be removed.

Measuring and Mixing

28. *Measuring.*—The method of measuring the materials for the concrete or mortar, including water, shall be one which will insure separate and uniform proportions of each of the materials at all times. A sack of portland cement (94 lb. net) shall be considered one (1) cu. ft.

29. *Machine Mixing.*—All concrete shall be mixed by machine except when the engineer shall otherwise permit under special conditions. A batch mixer of any approved type shall be used. The ingredients of the concrete or mortar shall be mixed to the specified consistency, and the mixing shall continue for at least one (1) minute after all materials are in the drum. The drum shall be completely emptied before receiving material for the succeeding batch.

30. *Consistency.*—The materials shall be mixed wet enough to produce a concrete of consistency that will flush readily under slight tamping, but which can be handled without causing a separation of the coarse aggregate from the mortar.

31. *Hand Mixing.*—When it is necessary to mix by hand, the materials shall be mixed dry on a water-tight platform until the mixture is of uniform color, the required amount of water added, and the mixing continued until the mass is of proper consistency and homogeneous.

32. *Retempering.*—Retempering of mortar or concrete which has partially hardened, that is, remixing with or without additional materials or water, shall not be permitted.

Forms

33. Forms for concrete curb shall be made of substantial materials, preferably steel forms. They shall be braced or staked so as to insure perfect alinement and grade. If the curb is precast, i.e., not molded in place, the forms, preferably steel, shall be so constructed that they will permit uniform spading and finish as herein specified.

Finish

34. After pouring concrete into the forms it shall be puddled and spaded so as to insure a thoro mixture, eliminate air pockets and create uniform and smooth sides.

Before the concrete has thoroly set, and while the concrete is still green, the forms shall be removed and the front and top sides shall be finished with a float or steel trowel to make a uniform finished surface.

Rounding Corners

35. Wherever corners are to be rounded, special steel trowels shall be used while the concrete is workable and the corners constructed to the dimensions herein specified.

36. For combined curb and gutter the top and side of curb and gutter may be finished by the use of a special-shaped trowel or curb-and-gutter machine which will shape the entire upper surfaces in accordance with the dimensions and shape specified. This trowel shall be used immediately upon removing the front form of the curb and while the concrete is still workable but firm enough to stand up.

Protection

37. *Treatment.*—As soon as the finished curb has hardened sufficiently to prevent damage, the surface shall be sprinkled with clean water or preferably covered with at least one (1) inch of wet sand or earth and kept wet for at least seven (7) days.

38. *Protection.*—The freshly finished curb shall be protected from hot sun and drying winds until it can be sprinkled and covered as above specified. The concrete surface must not be damaged or pitted by rain drops, and the contractor shall provide and use, when necessary, sufficient covering to completely protect all sections that have been placed within the preceding twelve (12) hours. The contractor shall erect and maintain suitable barriers to protect the curb from traffic and any section damaged from traffic or other causes, occurring prior to its official acceptance, shall be repaired or replaced by the contractor at his own expense in a manner satisfactory to the engineer. Before the street is opened to traffic the covering shall be removed and disposed of by the contractor. The street shall not be opened to traffic until the engineer directs.

39. *Temperature Below 35 Degrees Fahrenheit.*—If at any time during the progress of the work the temperature is, or in the opinion of the engineer will, within twenty-four (24) hours, drop to 35 degrees Fahrenheit, the water and aggregates shall be heated and precautions taken to protect the work from freezing for at least five (5) days.

Joints

40. All curb shall be cut clear thru so it will consist of sections about 6 feet long. These shall be cut by the use of steel templates where the curb is cast in place.

41. *Expansion Joints*—Shall be placed between sections of curb at intervals of fifty feet. These joints shall be filled with premolded bituminous material which will meet the requirements of A.S.M.I. specifications for coal-tar-pitch filler or asphalt filler. These joints shall be ½ inch in thickness.

At street intersections where the straight curb meets the curved section of curb similar expansion joints shall be placed.

Combined Curb and Gutter

42. *Dimensions.*—The standard cross-section of combined curb and gutter shall be as follows: Total width at base 24 inches; thickness of gutter slab, 6 inches; thickness at top of curb 5 inches, thickness of curb at gutter line 6 inches; height of curb above gutter 6 inches. The front face of the curb will have a batter of 1 inch from bottom to top and the top corner of curb face will be rounded to 1-inch radius while the intersection of curb and gutter shall be rounded to 1½-inch radius. The top of the gutter slab at the street edge shall be 5 inches below the top of the curb.

43. Proportion, materials, forms, measurements, mixing, consistency, finish, construction, protection, joints, expansion joints, etc., shall be in accordance with the specification herein given for concrete curb.

PRE-MOLDED REINFORCED CONCRETE CURB

44. Reinforced concrete curb, pre-molded, of the materials and dimensions shown on the plans shall be manufactured in standard lengths of six (6) feet by the method hereinafter specified, or some method equally good.

45. *Forms.*—Collapsible forms shall be used which may be designed to cast a series of units. Ends must be square with top and sides.

Of the two faces which are to be exposed after laying, one or both shall be cast against a steel form. If only one is cast against a steel form the other shall be trowel-dressed.

The above mentioned forms shall have fastened to them by means of bolts not more than three (3) feet apart, a metal corner-bar. This bar must be correctly placed so that its rounded portion makes a smooth connection with the top and face surfaces.

46. *Concrete for Curb.*—The concrete in curb manufacture shall contain for each sack of cement, 2 cubic feet of dry sand, and 3 cubic feet of washed gravel or crushed stone, screened so that all pieces shall pass a three-fourths (¾)-inch ring and 95 per cent of the gravel or stone shall be retained on a one-fourth (¼)-inch ring.

It shall be machine-mixed by batches, each batch being revolved for at least 3 minutes after the last ingredient has been placed in the drum.

47. *Consistency.*—Concrete shall be of such consistency that it may be placed and compacted without excessive ramming, but the use of excess water in order to secure a flowing concrete will not be permitted. The consistency required is that generally described as creamy. The amount of water to be used in mixing will be determined from time to time by the engineer, and when once determined shall be used for each batch until further notice. This uniformity shall be secured by measuring the water in the water tank on the mixer, which tank shall be equipped with a gage-glass graduated to gallons and quarters.

48. *Withdrawal of a Mixed Batch.*—Under no circumstances will a mixed batch or any part thereof be removed from the drum during the process of placing the succeeding batch in the drum.

49. *Finish.*—The concrete shall be poured and manipulated in such a manner that the top and face of the curb shall have plane surfaces, showing no coarse aggregate or pockets. Care must be taken not to disturb the corner bar.

As the forms are removed and while the concrete is green, the top and ten inches of the face shall be rubbed down with a plane wood-block.

50. *Protection.*—While curing, the curb shall be protected from direct rays of the sun and shall be kept moist for at least ten days before placing in curb trench.

51. *Closures.*—Special: Cutting of concrete curbstones will in in no case be permitted. Short lengths for final closures, which are to permit of special locations of drop curbs, shall be made to dimension for the particular purpose, either separately, as in the case of standard lengths, or may be cast in place in the street after the other curb has been set and concreted.

The specifications above given were adopted by letter ballot of the members by votes varying from 14 for and 4 against to 16 for and 1 against, as shown by the report of the Canvassing Committee on page 406.

PRESIDENT NORTON: The next matter upon the program is the report of the Special Committee on Foundations for Pavements, R. K. Compton, Chairman.

REPORT OF THE SPECIAL COMMITTEE ON FOUNDATIONS FOR PAVEMENTS

The resolution at the Buffalo Convention, creating the Committee on Foundations, instructed that committee to consider foundation other than concrete, and if, in the opinion of the committee, such methods were desirable, to submit tentative specifications to the Society.

Your committee finds that this is a very live and important subject which, at this time, is receiving the study and close attention of engineers and technical societies all over the country. In many cases the old macadam base is preserved, shaped up and utilized as a pavement foundation, while in other cases, municipalities have resorted to the use of a bituminous foundation, known as black base.

Your committee presented in Advance Papers, a tentative specification for old and new macadam base, and presents herewith tentative specifications for an asphaltic base, asphaltic concrete type, and also tentative specifications for tar-bound base, cold penetration type, and tar-bound base, hot penetration type. A close study must also be made of the sub-grade and its relationship to the thickness and character of base, and particular attention must be given to the drainage question, as it affects the sub-grade.

The Committee is at present composed of the chairmen of the respective specification committees, with the chairman of the asphalt committee acting as chairman of the foundations committee ex officio.

In view of the importance of this work and the close study which must be given this subject in all of its phases, your committee recommends that this be made one of the standard committees and that its personnel be selected from the active membership at large.

Your committee further recommends that this committee be instructed to work in conjunction with the committee on sub-grade and its relation to road surfacing of the Federal Highway Council.

It is hoped the incoming committee will be able to submit standard and definite specifications to the next Convention, as we consider this one of the most important subjects at this time.

R. K. COMPTON, *Chairman*
E. H. CHRIST
LINN WHITE
HERMAN H. SMITH

BROKEN-STONE FOUNDATIONS FOR PAVEMENTS

Subgrade. In the case of the construction of new broken-stone foundations for pavements the subgrade shall be prepared by cutting or filling as may be required to produce a surface parallel with the finished grade of the wearing surface and a distance below the finished grade equal to the specified thickness of the foundation and paving material.

The subgrade shall be brought to a firm, unyielding surface by rolling the entire area with a three-wheel road-roller weighing at least ten tons, and all portions of the surface of the subgrade which are inaccessible to the roller shall be thoroly tamped with a hard tamper weighing not less than forty pounds, the face of which shall not exceed eighty (80) square inches in area. All soft, spongy, or yielding spots and all perishable matter shall be entirely removed and the space filled with suitable material.

When considered necessary or of assistance in producing a compact, solid surface the subgrade before being rolled shall be sprinkled with water.

Sub-Drainage. When the soil is of such a character that it retains an excessive amount of moisture, such as clay subject to swelling or heaving under the action of frost, or sands similar to quicksand that do not afford a ready natural drainage, subdrains should be provided.

These may be of two general kinds, first, tile drains of open porous material or vitrified tile laid with open joints; second, trenches filled with broken stone, gravel, cinders or other similar material.

In some cases it may be sufficient to construct a sub-drain on each side of the roadway at or near the lines of the gutters, but when the soil is of a very wet nature, it may be advisable to lay additional lines of drains which may be in or near the middle of the roadway. This system of drains may be varied by diagonal lines of drains running from near the crown of the roadway to the gutters.

In all cases the drains should have connections with the existing sewers, catch basins or inlets.

New Macadam Foundation. If the pavement is to be laid on a new macadam foundation, the macadam shall be built as follows:

The total thickness of the macadam base will vary according to character of soil, drainage, kind of stone available, etc. In general the macadam base should be constructed of broken stone which is sound, hard and durable under traffic. The broken stone should be separated into different sizes by screening, the smaller sizes with the dust being used to fill and bond together the larger sizes. The thickness of the base should be regulated by experience in constructing ordinary water-bound macadam roads in similar situations, the total thickness of base being made the same or a little less than well constructed macadam.

After the subgrade has been properly prepared, spread a layer of clean stone passing a three (3) to three and one-half (3½)-inch revolving screen and held on a two (2)-inch screen to a depth sufficient when thoroly rolled to form about two-thirds (⅔) of the total thickness of the base. The thickness of this layer should be regulated by laying on the subgrade at proper intervals cubical blocks of wood of the proper dimensions to give the desired thickness or regulated by other means approved by the engineer. Over this layer of stone, spread with shovels stone screenings in sufficient quantity to fill the voids between the larger stone. The screenings should be spread gradually, and be thoroly rolled with a road roller weighing at least ten (10) tons during the process of spreading the screenings. As the screenings are worked into the coarse stone under the roller, more should be added here and there where voids appear. At first the rolling should be done dry (working from the edges towards the center of the roadway), until the stone appears to be well filled, then the surface should be well sprinkled and again rolled, the rolling and sprinkling continuing until the layer of stone is thoroly compacted and no more screenings can be worked in. Just enough screenings shall be used to fill and bond the stone, leaving no surplus screenings on the top.

The above method may be varied by using the crusher-run of stone without the addition of any other filler where the small sizes are not in excess. Also a filler other than stone screenings, such as bank gravel or sand may be used in some cases where experience with the materials available shows that better results can be obtained. Under some conditions the character of soil and stone available may be such as not to require the use of any filler with the stone of the first course. The specifications given, however, represent the best average practice where stone with bonding value, such as limestone or trap rock, can be obtained.

When the first layer of macadam is completed as specified, spread a second layer of clean stone passing a two (2)- or two and one-half (2½)-inch screen and held on a one (1)-inch screen to a depth sufficient when thoroly rolled to form the remaining one-third (⅓) of the total thickness of the base. Over this layer of stone spread evenly with shovels stone screenings and roll with the application of water by sprinkling until the layer of stone is well filled, well bonded and firmly set in place. In the case of bituminous pavements, just enough filler should be used to accomplish this purpose and not enough to form a layer or film over the surface of the stone. In fact it is better not to fill the stone quite flush, leaving the coarse particles of stone slightly projecting, so as to have a coarse, grainy base upon which to put the wearing surface. In the case of block or brick pavements, enough screenings should be used to produce a smooth, evenly filled surface.

The thickness of the base should vary according to local conditions and should be fixed by the engineer in charge when all the varying conditions of soil, drainage, traffic and materials of construction are understood. In general, a thickness of macadam base of eight inches will be enough for any except the most adverse conditions, and a base of four to four and one-half inches will meet the most favorable conditions of firm, unyielding soils and light traffic.

Old Macadam Foundation. If the pavement is to be laid on an old macadam base, the surface shall be thoroly swept and cleaned of all fine material that may be caked upon the surface of the stone or lying loose as dust, thereby exposing the clean coarse stone for the reception of the bituminous concrete.

If the old macadam does not present the desired coarse, grainy surface, or is not at proper and satisfactory grade after cleaning, it shall be spiked up and redressed to the desired crown and grade, the coarse stone being brought to the top by harrowing or otherwise, or new stone added when, in the opinion of the engineer in charge, it is needed to give the necessary thickness or character of surface. It shall then be thoroly rolled with the use of water as may be required.

In the case of bituminous pavements a layer about one stone deep of new, clean stone, averaging one and a half (1½) inches in size, shall be spread over the surface after redressing and rolling the old macadam, and finally rolled until firmly set in place without the application of water. This is intended to form a coarse, grainy surface of fresh clean stone which will bond with the bituminous paving material.

SPECIFICATION FOR ASPHALTIC BASE

(*Asphaltic Concrete Type*)

1. *General Description.* (a) The asphaltic base shall consist of a mineral aggregate composed of coarse aggregate and fine aggregate, uniformly mixed with asphalt cement and shall have a compacted thickness of———inches.

(b) All materials and methods of construction shall conform to the requirements of these specifications.

2. *Coarse Aggregate.* (a) The coarse aggregate for asphaltic base mixture shall consist of broken stone, broken slag, mine tailings or gravel. It shall be of reasonably uniform quality and shall be free from dust and an excess of flat or elongated pieces. Rock or mine-tailings from which it is produced shall have a per cent of wear of not more than five (5). Slag from which it is produced shall have a per cent of wear of not more than ten (10) and shall for each commercial size used weigh not less than seventy (70) pounds per cubic foot. If gravel is used it shall be composed of sound, hard, durable pebbles, free from clay or coatings of any character.

(b) When tested by means of laboratory screens the coarse aggregate, which may consist of one or more commercial products, shall meet the following requirements.

Passing 2½-inch screen, not less than	95 per cent
Passing 1¼-inch screen	25 to 75 per cent
Passing ¼-inch screen	0 per cent

Material which passes the ¼-inch screen in such commercial products shall in laboratory tests and for the purpose of proportioning the mixture be considered as fine aggregate.

3. *Fine Aggregate.* The fine aggregate for asphaltic base mixture shall consist of sand composed of clean, hard, durable grains, free from clay, loam and other foreign matter, together with particles which pass a ¼-inch laboratory screen which may be present

in the coarse aggregate material. When tested by means of laboratory screens and sieves the sand or total fine aggregate shall meet the following requirements:

Passing	Retained on	Per Cent
Passing ¼-inch screen	....	100
Passing ¼-inch screen	10-mesh sieve	0 to 20
Passing 10-mesh sieve	40-mesh sieve	15 to 50
Passing 40-mesh sieve	80-mesh sieve	25 to 65
Passing 80-mesh sieve	200-mesh sieve	7 to 40
Passing 200-mesh sieve	....	0 to 6

4. *Asphalt Cement.* The asphalt cement shall be homogeneous, free from water and shall not foam when heated to 175°C. (347° F.). It shall meet the following requirements for physical and chemical properties:

I. Specific Gravity 25°/25°C. (77°/77°F.) not less than 1.000

II. Flash point not less than 175°C. (347°F.).

III. Penetration at 25°C. (77°F.), 100 g., 5 sec., 40-70.

(Between these limits the exact penetration within a 10-point range shall be as directed by the engineer).

IV. Ductility at 25°C. (77°F.) not less than 30.

V. Loss at 163°C. (325°F.), 5 hours, not more than 3%.

Penetration of residue at 25°C. (77°F.), 100 g., 5 sec., as per cent of original penetration, not less than 50%.

VI. Per cent of total bitumen soluble in carbon tetrachloride, not less than 99%.

5. *Sources of Supply.* (a) Approval of sources of supply of coarse and fine aggregate under these specifications shall be obtained from the engineer prior to delivery of material and samples of each shall be submitted as directed by the engineer.

(b) A one-pound sample of the asphalt cement that the contractor proposes to use in his work, together with a statement as to its source and character, must be submitted with his bid. If the contractor proposes to prepare the asphalt cement at the paving plant, then in lieu of the above, a one-pound sample each of flux and refined asphalt must be submitted with his bid, together with a statement as to the source and character of each and proportions in which they will be combined to produce the asphalt cement which he proposes to use. No asphalt cement, flux or refined asphalt, other than that specified in his bid, shall be used by any contractor except with the written consent of the engineer, and provided that the asphalt cement used shall comply in all respects with the requirements of these specifications.

6. *Methods of Testing.* Methods of testing shall be as follows:

(a) Per cent of wear of rock, mine tailings or slag, Standard Test D2-08 American Society for Testing Materials. When testing slag 4000 c. c. loose measure of the size specified in the standard test shall be used.

(b) Weight per cubic foot of broken slag, Tentative Standard Method C29-20T American Society for Testing Materials.

(c) Screen test of coarse aggregate, Standard Method D18-16, American Society for Testing Materials.

(d) Sieve test of fine aggregate, Standard Method D7-18, American Society for Testing Materials.

(e) Physical and chemical properties of asphalt cement.

I. Specific Gravity, U. S. Dept. of Agriculture, Bulletin 314, p. 5.

II. Flash Point (open cup) U. S. Dept. of Agriculture, Bulletin 314, p. 17.

III. Penetration, A. S. T. M. Standard Test D5-16.

IV. Ductility, Trans. A. S. C. E. Vol. LXXXII, 1918, p. 1460.

V. Volatilization Test, U. S. Dept. of Agriculture, Bulletin 314, p. 19, using 50-gram sample.

VI. Bitumen soluble in carbon tetrachloride, U. S. Department of Agriculture Bulletin 314, p. 30.

Preparation and Composition of Mixture

7. *Preparation of Asphalt Cement.* (a) The asphalt cement shall be melted in kettles designed to secure uniform heating of the entire contents and shall be brought to a temperature of 250°F. to 350°F.

(b) When refined asphalt is to be combined with a flux the mixture shall be thoroly agitated until a homogeneous asphalt cement of the required penetration is produced. The penetration of the asphalt cement shall be tested at suitable intervals to insure that it is maintained at a uniform consistency thruout the period of use.

8. *Preparation of Mineral Aggregate.* (a) The coarse and fine aggregates for asphaltic base mixture shall be dried and heated at the paving plant in suitably designed revolving driers. They shall be heated to a temperature of 225°F. to 350°F. as determined on the mixing platform. The aggregate may be simultaneously fed into the same drier but in such case they shall immediately after heating be screened into coarse and fine aggregate and stored in separate bins, except in plants where the aggregates are proportioned and dried by the batch method.

(b) A registering pyrometer shall be installed at a suitable point at the discharge end of the drier with the registering device so located as to clearly indicate to the drum firemen the temperature of the mineral aggregate when discharged.

9. *Preparation and Composition of Asphaltic Base Mixture.* (a) The coarse and fine aggregate for asphaltic base mixture shall be measured separately and accurately either by weight or volume

for each batch to be mixed. The required quantity of hot asphalt cement for each batch shall be measured by actual weighing with scales attached to the asphalt-cement bucket. The mixture shall be made in an approved twin pug or batch mixer by first charging it with the coarse aggregate and fine aggregate. After these have been thoroly mixed the asphalt cement shall be added and the mixing continued for a period of at least forty-five (45) seconds or longer if necessary to produce a homogeneous mixture in which all particles of the mineral aggregate are uniformly coated.

(b) The constituents of the asphaltic base mixture shall be combined in such proportions as to produce a mixture conforming to the following composition limits by weight.

Passing 2½-inch, retained on 1-inch screen	15 to 45 per cent
Passing 1¼-inch, retained on ¼-inch screen	15 to 45 per cent
Total of the above two grades	53 to 70 per cent
Passing ¼-inch screen	25 or 40 per cent
Bitumen (asphalt cement soluble in carbon disulphide)	4 to 7 per cent

10. *Paving Plant Inspection.* For the verification of weights or proportions and character of materials, and determination of temperatures used in the preparation of the mixture the engineer or his authorized representatives shall have access at any time to all parts of the paving plant.

11. *Transportation of Mixture.* The asphaltic base mixture shall be transported from the paving plant to the work in tight vehicles previously cleaned of all foreign materials and when directed by the engineer each load shall be covered with canvas or other suitable material of sufficient size to protect it from weather conditions. No loads shall be sent out so late in the day as to interfere with spreading and compacting the mixture during the daylight unless artificial light satisfactory to the engineer is provided.

12. *Placing Asphaltic Base Mixture.* Prior to the arrival of the asphaltic base mixture on the work the prepared sub-grade or underlying course shall be cleaned of all loose and foreign materials. The mixtures shall be delivered at a temperature of 225° F. to 325° F. It shall be laid only when the prepared sub-grade or underlying course is dry or at least free from standing water and only when weather conditions are suitable. Upon arrival on the work it shall be dumped outside of the area on which it is to be spread and shall then be immediately distributed into place by means of hot shovels and spread with hot rakes in a uniformly loose layer of correct depth. No more asphaltic base shall be placed in advance of laying the surface course than can be covered by one day's run of the paving plant on surface mixture.

13. *Compacting Mixture.* While still hot the asphaltic base mixture shall be thoroly and uniformly compressed by a power-

driven roller weighing not less than ten (10) tons except that a tandem roller not less than eight (8) tons may be used if approved by the engineer. Rolling shall start longitudinally at the sides and proceed toward the center of the pavement, overlapping on successive trips by at least one-half the width of the roller, until all roller marks are eliminated. The motion of the roller shall at all times be slow enough to avoid displacement of the hot mixture and any displacement shall at once be corrected by the use of rakes and of fresh mixture where required. Rolling shall proceed at an average rate not to exceed two hundred (200) square yards per hour per roller, and shall continue until no further compression is possible. To prevent adhesion of the asphaltic base mixture to the roller, the wheels shall be kept properly moistened, but excess of either water or oil will not be permitted.

(b) Along curbs, headers and similar structures and at all places not accessible to the roller the mixture shall be thoroly compacted with hot tampers.

(c) The surface of the mixture after compression shall be smooth and true to the established crown and grade. Any mixture which becomes loose or broken, mixed with dirt or in any way defective prior to laying the surface course, shall be removed and replaced with fresh hot asphaltic-base mixture, which shall be immediately compacted to conform with the surrounding area.

14. *Joints.* Placing of the asphaltic base shall be as nearly continuous as possible, and the roller shall pass over the unprotected end of the freshly laid mixture only when the laying of the base is to be discontinued for such length of time as to permit the mixture to become chilled. In all such cases, including the formation of joints as hereinafter specified, provision shall be made for the proper bond with new surface mixture by cutting or trimming back the joint so as to expose an unsealed or granular surface for the full specified depth of the course. At the end of each day's work on base mixture, joints shall be formed by laying and rolling against boards of the thickness of the compacted mixture, placed across the entire width of the pavement, or by such other method as may be approved by the engineer. When the laying of the asphaltic base mixture is resumed the exposed edge of the joint shall be painted with a thin coat of hot asphalt cement or asphalt cement thinned with naptha, and the fresh mixture shall be raked against the joint, thoroly tamped with hot tampers, and rolled.

15. *Protection of Asphaltic Base.* If at the time of laying asphaltic-base mixture side supports such as curbs, edgings, gutters or shoulders have not been constructed, planks of suitable thickness shall be laid along each side of the pavement so as to prevent the mixture from squeezing out under the roller. These planks shall remain in place until final compaction has been obtained. Sections of compacted mixture shall be kept clean and as free from traffic as possible prior to laying the surface course.

16. *Conditions Prior to Laying Surface Course.* Immediately before laying surface course the base shall be cleaned of all dirt or other foreign material so as to present a uniformly rough or granular appearance admitting of complete bond with the wearing course. It shall preferably be warm when the surface course is placed.

SPECIFICATION FOR TAR-BOUND BASE, HOT PENETRATION TYPE

Drainage: The road bed shall be perfectly drained. Side-drains, cross-drains, and V-drains shall be provided as shown on engineer's plan, where required by local conditions.

Roller: The roller used shall be a power roller of a type suitable for macadam road construction and shall weigh 10 to 15 tons.

Sub-Grade: Before the stone is spread, the road bed shall be shaped to cross section by excavating, filling and thoroly rolling.

Stone: The stone shall be of best quality crushed rock (or other approved road metal) free from dust, loam or clay.

Base Course: The lower course shall consist of crushed stone which shall pass a three and one-half (3½)-inch ring and be retained on a two and one-quarter (2¼)-inch ring, spread to a finished depth of........inches, but........inches below the finished grade. The course shall be filled thoroly with clean sand, gravel, stone screenings or similar filler approved by the engineer, and rolled until smooth and firm. No filler shall be left on the surface.

Waterproofing Course: The waterproofing course shall be placed on the base and shall consist of a layer of crushed stone which shall pass a two and one-quarter (2¼)-inch ring and be retained on a one and one-quarter (1¼)-inch ring, spread to a finished depth of not less than two and one-half (2½) inches. (See Note.) This course shall not be filled but shall be keyed thoroly together by rolling. The surface shall be left smooth and of even texture, clean and free from dirt, clay, stone dust or other material which will prevent the easy penetration of the refined tar.

First Coat of Refined Tar: Refined tar, as hereinafter specified, heated to a temperature of not less than 200°F., and not more than 275°F., shall be spread uniformly over the surface when dry to the amount of not less than one and seven-tenths (1-7/10) gallons, nor more than one and eight-tenths (1-8/10) gallons to the square yard.

Three-quarter-Inch Stone: Three-quarter (¾)-inch crushed stone without dust, i. e., stone which shall pass a one and one-quarter (1¼)-inch ring and be retained on a one and one-half (1½)-inch ring, shall be spread over the surface, filling the voids, but leaving none on the surface. This course shall then be rolled until firm. The road shall be swept free from any particles of stone not held by the refined tar.

If the wearing course is to be a block pavement, a sand-tar cushion, as hereinafter specified, shall be laid over the base as completed in the above section.

If the wearing course is to be sheet asphalt or bituminous concrete the waterproofing course shall be finished as follows:

Second Coat of Refined Tar: Not less than one-half (½) nor more than three-quarters (¾) of a gallon of refined tar to the square yard, heated to a temperature of not less than 200°F., nor more than 275°F., shall be spread over the surface of the waterproofing course, and covered with stone screenings or sharp sand. The road shall then be rolled until compacted. All loose screenings or sand shall be swept off, and the wearing course shall be laid directly on the completed waterproofing course.

Sand-Tar Cushion: Upon the completed foundation course shall be spread a course ¾″ thick, of sand, mixed with refined tar for surface treatments (See A. S. M. I. Specifications 1918, p. 365), in the proportion of 90% sand and 10% refined tar, by volume. The sand shall be clean and dry and shall be mixed with the refined tar until a uniform, homogeneous mixture is obtained. It shall then be spread on the foundation course, and shaped to a true surface parallel to the surface of the finished pavement.

NOTE: This size stone is best for trap rock or hard rock which does not break under the roller. If limestone or other soft rock is used, a larger size stone may be used to advantage.

(1) *Refined Tar "G" A. S. M. I. Proceedings, 1915, p. 437:* The refined tar shall be homogeneous, free from water and shall not foam when heated to 150° C. (302°F.)

(2) Its specific gravity at a temperature of 25°C. (77°F.) shall be not less than 1.200 nor more than 1.300.

(3) When tested by means of the New York Testing Laboratory float apparatus, the float shall not sink in water maintained at 50°C. (122°F.) in less than 140 seconds nor more than 170 seconds.

(4) Its bitumen is determined by its solubility in chemically pure carbon disulphide at room temperature shall be not less than 75.0 per cent nor more than 90.0 per cent, and it shall not show more than 0.2 per cent ash upon ignition of the material soluble in carbon disulphide.

(5) When distilled according to the tentative method recommended by Committee D-4 of the American Society for Testing Materials in 1911, it shall yield no distillate at a temperature lower than 170° C. (338°F.); not more than 10.0 per cent by weight shall distill below 270°C. (518°F.), and not more than 20.0 per cent be weight shall distill below 300°C. (572°F.)

(6) The total distillate from the test made in accordance with clause (5) shall have a specific gravity at a temperature of 25° C. (77°F.) of not less than 1.030.

(7) The melting point, as determined in water by the cube method, of the pitch residue remaining after distillation to 300° C. (572°F.), in accordance with the test described in clause (5), shall not be more than 75° C. (167°F.)

Refined Tar for Sand-Tar Cushion: The refined tar for base and cushion shall conform to the requirements for "Refined Tar for Surface Treatments," A. S. M. I. Specifications for 1918, page 365 of the Proceedings for 1918.

Its specific gravity at 25°/25°C. (77°/77°F.) shall not be less than 1.100 nor more than 1.180.

When tested by means of the Engler viscosimeter at 40°C. (104°F.) the specific viscosity of the first 50 cubic centimeters passing the orifice of the viscosimeter shall be not less than 10 nor more than 35, with a maximum range not exceeding 5.

NOTE: Low specific viscosities should be used for work in the northern states and high specific viscosities for work in the southern states.

Its bitumen, as determined by its solubility in chemically pure carbon disulphide at room temperature, shall not be less than 90 per cent.

When distilled according to the American Society for Testing Materials Standard Method, it shall yield not more than 5 per cent of distillate at a temperature lower than 170 C. (338 F.); not more than 30 per cent shall distil below 270 C. (518 F.); and not more than 40 per cent shall distil below 300 C. (572 F.)

SPECIFICATION FOR TAR-BOUND BASE, COLD PENETRATION TYPE

Drainage: The road bed shall be perfectly drained. Side drains, cross drains and V-drains shall be provided as shown on engineer's plan, where required by local conditions.

Roller: The roller used shall be a power roller of a type suitable for macadam roads construction and shall weigh ten to fifteen tons.

Sub-Grade: Before the stone is spread, the road bed shall be shaped to cross section by excavating, filling and thoroly rolling.

Stone: The stone shall be of best quality crushed rock (or other approved road metal), free from dust, loam or clay.

Base Course: The lower course shall be crushed stone which will pass a 3½-inch ring and be retained on a 2½-inch ring, spread to a finished depth of........ inches, but........ inches below the finished grade. The course shall be filled thoroly with sharp sand, gravel, stone or slag screenings or similar filler approved by the engineer and rolled until smooth and firm. No filler shall be left on the surface.

If a deep foundation course is necessary, the stone shall be laid and rolled in separate layers not over 4 inches in thickness. When local conditions require, Telford may be substituted for part of the broken stone foundation.

Waterproofing Course: The waterproofing course shall be placed over the base thus prepared and consist of a layer of stone which will pass a 2¼-inch ring, and be retained on a 1¼-inch ring, spread to a finished depth of not over 3 inches. This stone shall be rolled dry until it is thoroly locked together and shows no movement under the roller and shall be even and true to the lines, grades and cross-sections.

Filling Waterproofing Course: The filler shall be broken stone or broken slag screenings, or sand, and be rolled into the stone by spreading in light even applications over the surface, keeping the roller passing back and forth and adding more filler as it rattles into the voids, and continuing these operations until the filler is flush with the surface of the stone; to be done without water. When the voids are filled, water shall be used and more filler added as needed to bring it flush with the surface of the stone. If sand is used for the filler, slag or stone screenings may be used with the water to finish up. Sufficient filler and water to form the usual grout or to cover the stone shall not be used. Traffic shall be kept off the road while it is drying out and any excess of filler on the surface shall be swept off, so that the stone shall be exposed.

Applying Refined Tar: When the road is dry, one gallon of refined tar, as hereinafter specified, per square yard, or more if the road will absorb it, shall be applied in two or more uniform applications. Each application shall be allowed to penetrate so that it will not pick up before applying the next.

Covering and Rolling: The covering material shall be either clean, dry sand, or granulated slag. The covering shall be spread within two to four hours after the last application of refined tar, and sufficient used to prevent the roller from picking up the binder. The foundation shall then be thoroly rolled. At the conclusion of the rolling the refined tar shall just show thru the cover.

If the wearing course is to be sheet asphalt, it shall be laid on this surface. If the wearing course is to be a block pavement, it shall be laid on a sand-tar cushion.

Sand-Tar Cushion: Upon the completed foundation course shall be spread a course ¾ inch thick of sand, mixed with refined tar as herein after specified, in the proportion of 90% sand and 10% refined tar, by volume. The same shall be clean and dry and shall be mixed with the refined tar until a uniform, homogeneous mixture is obtained. It shall then be spread on the base course and shaped to a true surface parallel to the surface of the finished pavement.

Refined Tar for Base and Cushion: The refined tar for base and cushion shall conform to the requirements for "Refined Tar for Surface Treatments," A. S. M. I. Specifications for 1918, page 365 of the Proceedings for 1918.

Its specific gravity at 25°/25° C. (77°/77° F.) shall not be less than 1.100 nor more than 1.180.

When tested by means of the Engler Viscosimeter at 40°C. (104°F.), the specific viscosity of the first 50 cubic centimeters passing the orifice of the viscosimeter shall be not less than 10 nor more than 35, with a maximum range not exceeding 5.

NOTE: Low specific viscosities should be used for work in the northern states and high specific viscosities for work in the southern states.

Its bitumen, as determined by its solubility in chemically pure carbon disulphide at room temperature shall not be less than 90 per cent.

When distilled according to the American Society for Testing Materials Standard Method, it shall yield not more than 5 per cent of distillate at a temperature lower than 170° C. (338°F.); not more than 30 per cent shall distill below 270° C. (518°F.); and not more than 40 per cent shall distill below 300°C. (572°F.)

PRESIDENT NORTON: Do I understand it is the desire of the committee to have these printed as tentative or move their adoption formally by letter ballot.

COL. COMPTON: I do not think it is advisable to have their adoption. I think I would print them as tentative information, and I so move.

The motion was duly seconded, put and carried.

PRESIDENT NORTON: This, gentlemen, goes thru our specifications reports on the program, except the matter of Broken Stone and Gravel Roads by Mr. Reimer. Mr. Reimer is not here and that matter will be passed as completed unless he wishes to take up the matter before the Convention at a later date.

We introduced on Monday, as required by the Constitution, two proposed amendments to our Constitution, which provides that such amendments shall be presented in writing on the first day of the Convention, and acted upon on the third day. The Secretary will please read these amendments as submitted by Chairmen Fisher and Tillson and their Committees.

Resolved, That Article III, Section 1 of the Constitution be amended to read:

Each Active and each Affiliated Member shall pay Seven Dollars and fifty cents per annum, and each Associate Member shall pay Fifteen Dollars per annum, all dues to be payable in advance on or before the first day of the annual convention; except that if more than one representative of a given company be Members, one shall pay a fee of Fifteen Dollars, and the others Seven Dollars and fifty cents each.

GEO. W. TILLSON
N. S. SPRAGUE
E. R. CONANT
JULIAN KENDRICK
EDWARD S. RANKIN

WILLIAM A. HOWELL
E. A. FISHER
FRED GIDDINGS
GEO. H. NORTON
CHAS. C. BROWN

PRESIDENT NORTON: You have heard this amendment. Does the Chairman of the Committee wish to make any remarks on the subject?

MR. TILLSON: As Chairman of that Committee, I would say that the Committee met and considered the matter very carefully—the question of what it would cost to run the society another year and how we could best raise the money. We did decide on certain economies in printing the annual report, and the Executive Committee decided to sell the Liberty Bonds to relieve the present indebtedness. We felt by increasing the dues fifty per cent we would have money enough to run the society another year and just about clear expenses, and therefore, I move that the amendment be approved and sent out to letter ballot.

The motion was duly seconded, put and carried.

The Secretary read amendment to Section 4, Article IV as follows:

Amend section 4 of Article 4 as follows:

General Committees

1. Street Paving, Sidewalks and Street Design, Street Maintenance and Street Railway Construction.
   Five members, one General Chairman, four remaining members to be Chairmen of the following sub-committees of three members each,
   A—Street Paving
   B—Sidewalks and Street Design
   C—Street Maintenance
   D—Street Railway Construction.
2. City Planning,
   Five members, one General Chairman, four remaining members to be Chairmen of the following sub-committees and three members each,
   A—Local Subdivisions
   B—Zoning
   C—Utilities
   D—Parking and Open Spaces.
3. Traffic and Transportation. Three members (*As amended below*).
4. Street Lighting. Three members.
5. Street Cleaning, Refuse Disposal and Snow Removal,
   Four Members, one General Chairman, three remaining members to be Chairmen of the following sub-committees of three members each,
   A—Street Cleaning
   B—Refuse Disposal
   C—Snow Removal.

6. Sewerage and Sanitation, Public Comfort Stations,
   Four Members, one General Chairman, three remaining members to be chairmen of the following sub-committees of three members each,
   - A—Sewerage
   - B—Sanitation including Sewage Disposal
   - C—Public Comfort Stations.
7. Water Works and Water Supply. Three Members.
8. Municipal Legislation and Finance. Three Members.
9. Fire Prevention. Three Members.
10. Public Markets. Three Members.
11. Convention Papers. Three Members.
12. Convention Arrangements. Three Members.

Add to specifications committees as follows:

10. Foundations and Sub-Grades.
11. Street Railway Pavements including Track Construction.

Omit sentence "Each General Committee shall consist of three members each."

E. A. FISHER
FRED GIDDINGS
WILLIAM A. HOWELL
T. CHALKLEY HATTON
GEO. W. TILLSON
R. KEITH COMPTON
G. D. FAIRTRACE
E. L. DALTON
JULIAN KENDRICK
E. R. CONANT

PRESIDENT NORTON: Does the Chairman wish to make any remarks upon the subject?

MR. FISHER: The purpose of these changes is to give a more general representation on these different committees. The Committee, say, on Street Planning, was divided into five sub-divisions, with a general chairman who would have general charge of the whole matter. It seemed to your Committee that it was better to do that than it was to enlarge the number of the committees. We have now a very large number of committees, and we believe that the work could be done better by having sub-committees under a general committee, than by enlarging the number of committees.

We have also added the specifications for foundations and subgrade as recommended by Mr. Compton and another on street railway pavements, including track construction.

I move the changes be passed to letter ballot.

The motion was duly seconded.

PRESIDENT NORTON: You have heard the motion that the changes as submitted be referred to letter ballot. Any discussion?

MR. BLANCHARD: Did I understand that the name of the first committee was to remain the same, namely, "Street Paving, Sidewalks and Street Design?"

MR. FISHER: Yes.

MR. BLANCHARD: Mr. President, I would strongly advise that the committee on traffic and transportation be allowed to stand by itself rather than be made a sub-committee of the Committee on City Planning, as a great many of the matters that would be presented would refer to the matter of street design. The report presented at this Convention contains one recommendation properly coming under city planning, whereas five or six other recommendations refer particularly to street design.

Furthermore, Mr. President, I do not favor the submersion of important committees as sub-committees of parent committees. Many of us are intensely busy, and it is not practicable at all times to spend four days at a convention. If, however, sub-committees properly function with parent committees, it is evident they should present their reports to the parent committee. Then the parent committee will give consideration to their recommendations and, if considered advisable, include them in the report to the society. We have been through that, Mr. President, in connection with the General Committee on Specifications. It seems to me the same arguments that were used in changing the Constitution in that respect, refer in part to this plan.

As an amendment to this amendment to the Constitution, I would move that the Committee on Traffic and Transportation be omitted as a sub-committee of the Committee on City Planning and remain an independent standing committee.

PRESIDENT NORTON: Does Mr. Fisher wish to accept that amendment?

MR. FISHER: We considered in discussing this, that the transportation and auto parking could properly come under this general subject of city planning, even if there were some things that perhaps technically might be considered under something else. I have no serious objection to taking this out if there seems to be a reasonable argument for it. I believe the general plan is a good one. I think we have so many committees now that we are not able to get thru the program in any reasonable time, if sufficient time is given for discussion. I think it will rather tend to consolidate and save time. I have no objection to that.

PRESIDENT NORTON: The Chairman of this Committee on Amendments is willing to make that change in the amended Constitution. Is there further discussion upon the subject? With that change then, the motion before the house is that these amendments to the Constitution be submitted to letter ballot.

The motion was put and carried.

PRESIDENT NORTON: The next upon the program is the report of the Committee on Resolutions.

Whereas, during the first session of this Convention word was received of the death of Mr. Michael J. Murphy, of St. Louis, Mo.

And Whereas, possibly more than to any other one man this Society is indebted for its inception in 1894,

And Whereas, Mr. Murphy served as its first and second President, therefore, be it resolved that this Society in convention assembled, hereby expresses its appreciation of the debt which it owes to Mr. Murphy and its deep sorrow in the loss which it has sustained in his death,

And be it further resolved that a copy of this resolution be sent to his bereaved family.

MR. COMPTON: I move the adoption of this resolution.

The motion was duly seconded and unanimously carried by a rising vote.

Resolved that the American Society for Municipal Improvements at this its twenty-sixth annual Convention hereby expresses its deep appreciation of the courtesies extended to it by the City of St. Louis, by the City Officials, individually and collectively, by the various civic organizations and by its public spirited citizens, and also by the ladies who have so cordially entertained the wives and daughters of the visiting delegates.

MR. COMPTON: I move the adoption of this resolution

The motion was duly seconded, put and carried.

MR. COMPTON: I have a resolution to introduce by request, and which relates to the United States Government becoming permanent member of the International Association of Road Congresses, and the holding of the next Congress in this country in 1922.

Resolved: That the American Society for Municipal Improvements favors the United States Government becoming a Permanent Member of the Permanent International Association of Road Congresses, and, therefore, be it further

Resolved: That the Congress of the United States pass the necessary legislation, during the months of November or December 1920, if practicable, to enable the United States to become a Permanent Member of the Association, and, be it further

Resolved: That the Secretary of State of the United States, as soon as Congress has authorized that the United States become a Permanent Member of the Association, be requested to extend an invitation to the Executive Committee of the Association to hold the Fourth International Road Congress in the United States in 1922, which invitation must be received by the Association prior to January 1, 1921, as otherwise the invitation of the Italian Government will be accepted, and, be it further

Resolved: That copies of these Resolutions be sent to the President of the Senate, the Speaker of the House of Representatives, the Secretary of State and the Secretary of Agriculture of the United States.

MR. TILLSON: I move the adoption of the resolution.

The motion was duly seconded, put and carried.

MR. SAMMELMAN: May I ask where applications for membership in this association may be sent?

MR. BLANCHARD: Professor Paul Le Gavrian, Secretary, Permanent International Association of Road Congresses, 1 Ave. d'Iena, Bureau 106, Paris, France.

PRESIDENT NORTON: We did not finish the morning's program, so we will take it up now. A matter discussed at the Round Table today, was the approval of the schedule of salaries, as adopted by the American Association of Engineers, and I would ask Mr. Hadden to present the matter to this society.

Mr. Hadden then placed the matter before the Society in detail and after some discussion it was unanimously voted that the American Society for Municipal Improvements approves the municipal engineers' salary schedule of the American Association of Engineers.

The next matter was carried over from our first session, "Valley Forge" by Mr. S. Cameron Corson.

The interesting paper and illustrations were presented but have not been supplied for printing here.

PRESIDENT NORTON: I am sure the pictures were appreciated, and a revelation to at least one person here. From my neck of the woods, very few people know of this most interesting spot, and I am sure it is a revelation, and a spot well worth visiting.

We will now have the paper on "Paving Brick and Brick Pavements" by Mr. J. C. Travilla, Consulting Engineer, St. Louis, Mo.

The paper will be found on page 247.

PRESIDENT NORTON: Is there discussion upon this paper? While we outlined for this afternoon to reach Mr. Sharples' paper, he has requested that the matter be put over until morning. This leaves for this afternoon two matters which have not been brought up. The first is "Brick vs. Block for City Street Paving" by Mr. S. Cameron Corson. This matter has been printed in the advance proceedings. Is there discussion upon this paper? (None presented.)

The paper will be found on page 253.

The other paper has also been printed in the advance proceedings—"Gravel: A Plea for Common-Sense Specifications" by Mr. Wallace F. Purrington, Chemist and Testing Engineer, State Highway Department, Concord, N. H. This is open for discussion, if you wish to take it up now. (No discussion.) It is an interesting paper, and I think speaks for itself.

The paper will be found on page 223.

That, gentlemen, leaves us with the program cleaned up, except the paper by Mr. Sharples and the discussion to be offered by Mr.

Davis. We will have a paper in the morning by Mr. Butterfield and Mr. Fred Shepheard. This concludes the business of this session.

Friday Morning, October 15, 1920

The meeting convened at 9:30 A. M., President George H. Norton presiding.

PRESIDENT NORTON: The first subject on the program this morning is "Width of Roadways for Different Classes of Streets" by Mr. Robert Hoffmann, Commissioner, Division of Engineering and Construction, Department of Public Service, Cleveland, Ohio. The Secretary will read the paper.

The paper will be found on page 112.

PRESIDENT NORTON: I would like to ask Mr. Compton if they have had any trouble in the repaving program in Baltimore in the business section, by reason of reconstruction of the areaways underneath the sidewalks.

MR. COMPTON: We have had a good deal of trouble, Mr. President. Our downtown streets are exceedingly narrow. They run from 32 feet to 52 feet and on nearly all we have double car tracks. In repaving, we have set the curb back, in some cases only a few inches to five or six feet, and then the areaway projected out to the curb. Some way or other we have managed to get thru. We have had a great deal of trouble with what we call the "area situation."

PRESIDENT NORTON: Is there any further discussion? At the session on sanitary matters, the announcement was made that Chairman Dallyn of the Committee on Sewerage and Sanitation was ill and unable to be with us. A letter has been received from him to the effect, enclosing several papers. These papers have been read by title. If our time would permit and the members desire, we will endeavor to take those up at a later time this morning.

The next upon our program for this morning is "Relation of the Proposed Uniform Vehicle Law to Municipal Traffic Regulations" by Henry G. Shirley, Secretary of Federal Highway Council, Washington, D. C., which will be presented by Mr. Compton.

The paper will be found on page 107.

PRESIDENT NORTON: Is there discussion upon the paper? If not, the next matter to be taken up is the first on this morning's program, the report of the Committee on Traffic and Transportation, by A. H. Blanchard, Chairman, Professor of Highway Engineering, University of Michigan, Ann Arbor, Michigan.

PROFESSOR BLANCHARD: The committee wishes to take this opportunity to extend its sincere thanks to the members of the society who actively co-operated with the Committee in submitting answers to questions contained in a questionnaire covering certain problems which the committee decided to take into consideration this year.

The report and discussion thereon will be found on page 100.

PROFESSOR BLANCHARD: Mr. Chairman, I move the adoption of this report.

PRESIDENT NORTON: You have heard the reading of the report, and it has been regularly moved that this report be approved. Is there discussion upon the motion?

The motion was duly seconded, put and carried.

PRESIDENT NORTON: Further discussion? If not the next matter upon the program is the report of the committee on Standard Tests for Bituminous Materials by Professor Blanchard.

The report will be found on page 142.

PROFESSOR BLANCHARD: In submitting this report, I wish to call attention of the members of the society to the fact that in the American Society for Testing Materials, which is the recognized society in this country for the standardization of tests, the committee on Standard Tests for Road and Paving Materials consists, at the present time, of fifty experts on the testing of highway materials, representing the entire United States. It has, at the present time, forty sectional committees, methods of testing and specifications for various materials.

It seems, therefore, highly undesirable that a committee in this Society, or a committee of the National Research Council, composed practically of the same men, with not as adequate facilities for developing the tests as the American Society for Testing Materials, should attempt to evolve new methods and in that way complicate the situation which exists at the present time along the line of multiplicity of methods of making tests.

The digest of the last recommendation is that this committee serve as a clearing house pertaining to standard tests for bituminous materials and keep this society up to date as far as the adoption of standard methods are concerned.

With these few words of explanation, I move the adoption of the report, Mr. President.

PRESIDENT NORTON: Your motion includes the recommendation for the continuance of this special committee?

PROFESSOR BLANCHARD: Yes.

PRESIDENT NORTON: Any remarks upon the report or the motion?

MR. TILLSON: In seconding that motion, I want to reiterate what Professor Blanchard has said. We all know the necessity of having exact methods of testing and the necessity of having all societies use the same methods, and it would seem absolutely futile and useless for us to attempt to make experiments to determine different tests when these other societies have the ablest men in the country, working along the same lines. I think, therefore, we are doing a benefit to everybody if we approve this report and adopt those recommendations. I, therefore, second the motion.

The motion was put and carried.

PROFESSOR BLANCHARD: Mr. President, following your suggestion, I believe it is time to introduce a motion to the effect that the incoming President appoint a Committee on Standard Tests for Non-bituminous Highway Materials, to function for the society in the field of standard tests for non-bituminous materials, just the same as a similar committee has functioned pertaining to bituminous materials.

It might seem that one committee would be sufficient, but in the Committee of the American Society of Testing Materials, composed of fifty men, there are two main sub-committees, one on bituminous and one on non-bituminous materials, and there are about twenty-eight men in each committee. In other words, there are a great many men who are working on one class of materials or the other, but there are only comparatively few who are working on both classes of materials, and therefore, I think it would expedite the work of this Society, if there were two committees. The committee now in existence only covers Standard Tests for Bituminous Materials. I make that motion.

The motion was duly seconded, put and carried.

PRESIDENT NORTON: We will take up one of the matters omitted from our last evening's program, a paper by Dr. Butterfield, Chemist of the Boro of Queens and Mr. Fred Shepheard, Engineer of Maintenance on "Experimental Pavements in the Boro of Queens."

The paper will be found on page 255.

PRESIDENT NORTON: Is there discussion upon Dr. Butterfield's paper? There is one item left over from our previous program, the paper by Mr. Sharples. Mr. Sharples was obliged to go out of town this morning, and his paper has been held until his return. It is on "The Protection of Gravel Roads by Surface Treatments" by Mr. Philip P. Sharples, Manager General Tarvia Department, The Barrett Company, New York City.

The paper will be found on page 209.

PRESIDENT NORTON: We have a discussion of this paper prepared by Mr. D. B. Davis.

Mr. Davis's paper will be found on page 216.

PRESIDENT NORTON: Gentlemen, is there further discussion upon the paper? If not, we have one more paper which will be short, and then we have a business matter before us, and we certainly want to see our new officers and give them a proper reception. We will have the paper on "Housing" by Mr. Nelson Cunliff, Secretary and Manager, Home and Housing Association, St. Louis, Mo.

The paper will be found on page 97.

PRESIDENT NORTON: The paper is now open for discussion. The Committee on Finance reports that books and accounts of the

Secretary and Treasurer have been examined and are found to be correct. This is signed by Frederick A. Reimer, Chairman.

Yesterday, a resolution was presented to this society, and as it was not in order during the regular program, it was postponed until this morning. Does Mr. Routh wish to present the matter again? It was in reference to further activities of the Association of Engineers. Several members of the Executive Committee have talked this matter over and if further presentation is made, it will be referred to the Executive Committee. (*Mr. Routh reported not present.*)

Your President wishes to express his sincere appreciation to the members, not only for their good attendance, but to express his appreciation to different members for cutting down their papers so as to accommodate the regular program.

In the coming year it is hoped that this society may continue the excellent work which was so well begun by the people of St. Louis in creating added interest in this society by laboring along constructive lines to bring up our membership and influence. I think no one has been more active in this than has Commissioner Kinsey, and I think we desire to express our appreciation to him and will be glad to hear how he did it.

MR. E. R. KINSEY: Gentlemen, from our point of view, we know the value of this Society to the City of St. Louis, and we felt certain it would be equally valuable to every other city, and so, ever since the last convention in New Orleans, we have been trying to spread the news around. One of the first steps was to circularize to the mayors thruout the United States, as early as last January, and a letter went out over the signature of our mayor, to several hundred mayors in the country, telling what great benefits St. Louis had obtained from former meetings of this Association, and advising those mayors to see to it that they had a share in it, and advising them to arrange annual budgets for their expense accounts for the engineers, and advising the mayors themselves to come. Following that up, there went out every month, circular letters of a personal character. Some signed by the Mayor and some over my signature to engineers and city officials over the country.

We had in mind two things: First, we wanted to stimulate attendance at this meeting. We knew we would not get everybody here we would address. I believe that every man who received literature during the past year from St. Louis, even tho he was not able to get here, has learned something about this organization. If that has been accomplished, we shall be very glad indeed. St. Louis has been very proud of this organization and is immensely pleased at the success of this Convention. We appreciate the attendance of those who have come and appreciate the activities of your officers who have made this success, and as I had occasion to say on the first day, we are very, very glad you came.

PRESIDENT NORTON: Perhaps it would not be out of order to pay some appreciation to that member who has traveled the longest distance, as we should appreciate the trouble he takes to come from Salt Lake City to attend these conventions, Mr. Cannon.

MR. CANNON: I thank you, Mr. President.

PRESIDENT NORTON: Of our new officers who are going to run this show in better shape next year, our new Treasurer is Mr. Smith. It is only necessary to look at Mr. Smith to convince the members that it is not well to monkey with the treasury.

Our new Vice-President, I regret exceedingly has disappeared, Mr. Dutton of Minneapolis.

In the East, we have a town, always full of the Presidents of this society, and it will continue to hold a prospective President, as well as past Presidents. Our First Vice-President, Mr. Rankin.

MR. RANKIN: Mr. President and gentlemen of the American Society for Municipal Improvements, I think Mr. Dutton took the wise step. Certainly, there is one thing we can say for St. Louis, they have given us a warm welcome. I have been warm ever since I struck the town. I have been very forcibly impressed since I have been here with the contrast between the convention held here in 1904, which happened to be my second—that you remember was the time of the World's Fair—and the present convention. We had our headquarters in one of the temporary hotels at the fair ground. I think our meeting room was about ten by twelve. I do not believe there were more than fifteen persons present at any one meeting. I may be wrong, but I do not think there was one, certainly not more than one official of St. Louis who attended any of the meetings. This society had about reached the irreducible minimum. Since then it has come up, and certainly the attendance at these meetings has proved the worth of the society.

In attempting to thank you for the honor which you have conferred on me, I feel very much like the young fellow in the story they tell who was making a call on a young lady in the afternoon, and the father invited him to stay for dinner—a very quiet family, and when they were seated at the table, the head of the house asked the guest to ask the blessing. It was somewhat out of his line, but he was a pretty good sport, so he just put his head down and said, "Thanks, awfully."

PRESIDENT NORTON: We have much to be thankful for at this convention, and the one thing which we have most to be thankful for, has been the wise provisions and excellent execution by the local committee. I believe this is due to a large extent to the wisdom of our second vice-president. I believe we would like to express to Mr. Horner our appreciation of all the committee did, and also to Mr. Sammelman, and hope that the same ability and industry will be carried into the new office of second vice-president.

MR. HORNER: Thank you. I want to say that my activities have been principally watching the antics of the Local Arrangements Committee of which Mr. Sammelman is Chairman. I have very carefully kept my hands off the details, and so to Mr. Sammelman is due the entire credit. The Committee of about seventy members, of whom half are municipal men, and the rest very good friends in similar organizations, have worked in perfect co-operation. We are sorry we cannot invite you back again next year.

A rising vote of thanks extended Mr. Horner and the Committee.

PRESIDENT NORTON: The President is supposed to make a retiring address as well as an introductory address, and all he can say at the present time is to again thank you and say that he is very glad to call up his successor, Colonel R. Keith Compton, as our next President. (Applause.)

PRESIDENT-ELECT COMPTON: Mr. President and gentlemen, I certainly want to thank you for the honor you have conferred upon me. I will not undertake to make a long speech, as I know you are looking forward this afternoon to the trip on the river, and after that is over you will naturally turn your way homeward. I think we have spent a most pleasant week, and held one of the most successful conventions this society has ever held.

Now, gentlemen, this society in the past has been entirely a working society. As I have said before, I have looked up to this society as a good thing to follow, and you will agree with me that the successful work of this society comes mostly from the work of the committees. There is room on the committees for a large percentage of our active membership.

Now, many of us are getting along in years, and we will retire, and it does seem to me that the younger men in this society should now be called upon to take the places of the older men, and keep up the record of the society. There are two ways of appointing committees. The natural inclination seems to be to scatter them over the various sections of the country. There is another way of selecting a committee within a certain local radius so they can hold meetings, but there is one thing sure, from my experience on committees—it is a very difficult thing to obtain a meeting before the convention. I hope the committees that are appointed this year will try their utmost to get together early in the season so they can do something for the next convention.

There is one other subject I wish to touch upon, gentlemen. I understand that you have decided to come to my home city next year. I want you all to know that Baltimore feels it is exceedingly honored. Your presence will honor us. St. Louis has set the pace for generous hospitality, but we will do our best to keep up with her. We have a good many things to show you.

I thank you, gentlemen, and I want to thank our President for the excellent way in which he has presided over our Convention, and I hope one year from now we will all meet together at Baltimore.

The Secretary advises there is no further business, and if that is the case, your presiding officer will announce the Convention adjourned.

RESULTS OF LETTER BALLOT ON PROPOSED CHANGES IN SPECIFICATIONS

In accordance with the votes of the Convention the proposed new specifications and changes in existing specifications printed in the preceding Business Proceedings of the Convention were submitted to letter ballot of the Active membership, the ballots being sent to a canvassing committee, consisting of E. S. Rankin, Chairman, M. R. Sherrerd and W. A. Howell, all of Newark, N. J. Following is the report of this canvassing committee, showing a definite majority for each section proposed, and all the specifications and changes in specifications passed to letter ballot have the official adoption of the Society. By inadvertence the proposed changes in the standard specifications for Stone Block Paving, which were referred back to the committee for another year's consideration, were included in the letter ballot and also received a majority of the votes cast.

Report of Canvassing Committee on Proposed Changes in Specifications

Proposed changes in Sheet Asphalt Paving Specifications.

I	for 17	against 2
II	for 12	against 5
III	for 18	against 0
IV	for 15	against 1
V	for 18	against 0
VI	for 17	against 1
VII	for 14	against 4
VIII	for 16	against 1
IX	for 11	against 7
X	for 14	against 4
XI	for 17	against 1
XII	for 13	against 5
XIII	for 11	against 7

Proposed Changes in Wood Block Paving Specifications.

All sections,	for 15	against 1

Proposed Changes in Brick Paving Specifications.

Section 7½	for 18	against 0
Section 8	for 14	against 5
Section 13	for 19	against 0
Section 16	for 18	against 0
Section 18	for 19	against 0
Section 19	for 18	against 0

Proposed Changes in Stone Block Paving Specifications.

Secs. 1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 15, for 16, against 0.

Section 10, for 15, against 1.

Proposed Specifications for Cement Concrete Paving.

Secs. 1, 4, 8, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, for 16, against 1.

Secs. 2, 3, 5, 6, 7, 16, 17, for 15, against 2.

Sec. 15, for 13, against 4.

Proposed Specifications for Sidewalks.

All sections, for 18, against 0.

Proposed Specifications for Curb.

All sections, for 14, against 1.

EDWARD S. RANKIN,
Chairman, Canvassing Committee.

Newark, N. J., January 5, 1920.

ATTENDANCE AT ST. LOUIS CONVENTION

W. Aldridge, Ac., Winnipeg, Manitoba
H. L. Alley, As., Boston, Mass.
A. M. Anderson, As., Chicago
Earl A. Anderson, Af., Cleveland, O.
E. Argo, E. St. Louis, Mo.
H. J. Arnstedt, G, St. Louis, Mo.
F. C. Askwith, Ac., Ottawa, Can.
Mrs. F. C. Askwith, G, Ottawa, Can.

C. E. P. Babcock, Ac., Buffalo, N. Y.
C. W. Barnes, Jr., G., St. Louis, Mo.
H. E. Barnes, Ac., Shreveport, La.
R. R. Barrett, As., New York City.
Harland Bartholomew, Ac., St. Louis, Mo.
Mrs. H. Bartholomew, G, St. Louis, Mo.
J. C. Bartley, Ac., New Orleans, La.
Edward Bartow, Ac., Iowa City, Ia.
H. F. Bascom, Ac., Allentown, Pa.
Theodore Beffa, G, St. Louis, Mo.
E. L. Benedict, As., Pittsburg, Pa.
A. E. Blackmer, As., St. Louis, Mo.
Arthur H. Blanchard, Ac., Ann Arbor, Mich.
Will P. Blair, As., Cleveland, O.
Erwin Bloss, G, St. Louis, Mo.
Miss Boehmer, G, St. Louis, Mo.
Miss Majorie Bohn, G, St. Louis, Mo.
A. A. Bonsack, G, St. Louis, Mo.
A. C. Boughton, G, St. Louis, Mo.
A. C. Boughton, Jr., G, St. Louis, Mo.
L. Roy Bowen, Ac., St. Louis, Mo.
Lt. Col. H. C. Boyden, G, Chicago, Ill.
H. Eltinge Breed, Ac., New York.
P. L. Brockway, Ac., Wichita, Kans.
W. A. Brown, G, Alton, Ill.
James N. Brown, G, St. Louis, Mo.
Chas. C. Brown, Ac., Valparaiso, Ind.
Walter Buehler, Ac., New York City.
W. W. Burden, Ac., St. Louis, Mo.
Mrs. W. W. Burden, G, St. Louis, Mo.
A. M. Buswell, Ac., Urbana, Ill.
Edgar J. Buttenheim, As., New York City.
Chas. S. Butts, Ac., St. Louis, Mo.
Miss Thelma Butts, G, St. Louis, Mo.
Wm. Buxman, G, New York City.

C. L. Campbell, As., St. Louis, Mo.
S. Q. Cannon, Ac., Salt Lake City, Utah
J. E. Carroll, Ac., St. Paul, Minn.
F. P. Cartwight, G, Rochester, N. Y.
W. H. Caruthers, As., St. Louis, Mo.
F. J. Cellarius, Ac., Dayton, O.
Mrs. F. J. Cellarius & Daughter, G, Dayton, O.
J. B. Chaplin, G, Memphis, Tenn.
Alden Chase, Ac., St. Louis, Mo.
J. T. Child, G, Rochester, N. Y.
Leland Chivvis, Ac., St. Louis, Mo.
Mrs. Leland Chivvis, G, St. Louis, Mo.
E. H. Christ, Ac., Grand Rapids, Mich.
Edward E. Christopher, Ac., St. Louis, Mo.
Oscar Claussen, Ac., St. Paul, Minn.
Thos. E. Collins, Ac., Elizabeth, N. J.
Mrs. Thos. E. Collins, G, Elizabeth, N. J.
R. K. Compton, Ac., Baltimore, Md.
E. R. Conant, Ac., Winchester, Mass.
C. M. Cooper, Ac., Columbus, Kans.
Mrs. C. M. Cooper, G, Columbus, Kans.
Luther Conant, Jr., G, Winchester, Mass.
Douglas Cornell, Ac., Buffalo, N. Y.
S. Cameron Corson, Ac., Norristown, Pa.
Jas. W. Costello, Ac., Newark, N. J.
John S. Crandell, As., New York City.
W. R. Crecelius, Ac., St. Louis, Mo.
Terrell Croft, G, University City, Mo.
Mrs. Terrell Croft, G, University City, Mo.
Harry Cronin, As., Pittsburg, Pa.
W. E. Crowell, As., Kansas City, Mo.
Chas. Cunliff, Ac., St. Louis, Mo.
Mrs. Nelson Cunliff, G, St. Louis, Mo.
C. H. Currie, Ac., Webster City, Iowa.
Francis T. Cutts, Ac., St. Louis, Mo.

E. L. Dalton, Ac., Dallas, Texas.
J. K. Davidson, Sr., G, Lithonia, Ga.
J. K. Davidson, Jr., G, Lithonia, Ga.
E. T. Davies, G, Minneapolis, Minn.
D. B. Davis, Ac., Richmond, Ind.
Harry Dawson, G, St. Louis, Mo.
W. W. DeBerard, As., Chicago, Ill.
A. Clinton Decker, Ac., Fairfield, Ala.
Chas. E. DeLeuw, Ac., Chicago, Ill.
F. H. Derby, G, University City, Mo.
M. B. Dewey, G.
Charles Deihl, G.
J. T. Dodds, Ac., St. Louis, Mo.
Geo. C. Dodge, G, New York City.
William C. Doerr, Af., St. Louis, Mo.
Harry Donnelly, G, Cincinnati, O.
Geo. W. Doran, G, Cincinnati, O.
Mrs. G. W. Doran, G, Cincinnati, O.
Miss Irene Doran, G, Cincinnati, O.
Louis Drach, G, Cincinnati, O.
Mrs. Louis F. Drach, G, Cincinnati, O.
J. R. Draney, As., New York City.

Ac.—Active Member; As.—Associate; Af.—Affiliate; G.—Guest; E.—Exhibitor.

A. D. Duck, Ac., Greenville, Texas
Chas. B. Dugan, G, Chicago, Ill.
R. C. Duncan, G, New Orleans, La.
E. R. Dutton, Ac., Minneapolis, Minn.

H. P. Eddy, Ac., Boston, Mass.
R. M. Elder, As., Chicago, Ill.
James H. Ely, G, St. Louis, Mo.
M. C. Erwin, San Antonio, Tex.
J. C. Essewein, G, St. Louis, Mo.
Daniel Evans, G, St. Louis, Mo.

J. D. Fairtrace, Ac., Dallas, Tex.
W. C. Ferguson, As., St. Louis, Mo.
James L. Ferebee, Ac., Milwaukee, Wis.
C. B. Filbert, As., New Orleans, La.
Alonzo Finn, G, St. Louis, Mo.
Edwin A. Fisher, Ac., Rochester, N. Y.
Geo. F. Fisk, Ac., Buffalo, N. Y.
Thos. E. Flaherty, G, St. Louis, Mo.
Mrs. T. E. Flaherty, G, St. Louis, Mo.
E. V. Ford, G, Kansas City, Mo.
G. B. Ford, Ac., New York City.
W. B. Fowler, Ac., Memphis, Tenn.
Frank X. Friedrich, Ac., Joliet, Ill.
F. J. Furlong, G, St. Louis, Mo.

J. J. Gartland, Jr., As., New York
R. C. Gaus, Ac., St. Louis, Mo.
K. C. Gaynor, Ac., Sioux City, Ia.
Warren George, G, St. Louis, Mo.
Fred Giddings, Ac., Charlotte, N. C.
M. A. Giff, G, St. Louis, Mo.
H. J. Gillum, As., Chicago, Ill.
C. S. Goldsmith, G, St. Louis, Mo.
W. R. Goodwin, G, Minneapolis, Minn.
R. H. Gould, G, St. Louis, Mo.
J. W. Graves, Ac., St. Louis, Mo.
E. R. Gray, Ac., Hamilton, Ont.

John W. Hackney, Ac., Atlantic City, N. J.
Samuel C. Hadden, Af., Chicago.
R. W. Halteman, G, St. Louis, Mo.
H. A. Hance, G, St. Louis, Mo.
F. S. Hancock, G, St. Louis, Mo.
O. F. Harting, Ac., St. Louis, Mo.
Mrs. O. F. Harting, G, St. Louis, Mo.
T. Chalkley Hatton, Ac., Milwaukee, Wis.
F. M. Hayden, E, Cleveland, O.
G. E. Heebink, Ac., Beloit, Wis.
Walter Heimbuecher, G, University City, Mo.
Mrs. W. A. Heimbuecher, G, University City, Mo.
Hans Helland, Ac., San Antonio, Texas
W. L. Hempelmann, As., Chicago, Ill.
M. Hennessey, G, St. Louis, Mo.
L. Heuerman, G, San Antonio, Texas
C. L. Heuer, G, St. Louis, Mo.
C. D. Hill, Ac., Chicago, Ill.
John B. Hittell, Ac., Chicago, Ill.
Mrs. J. B. Hittell, G, Chicago, Ill.
R. M. Hoffman, G, St. Louis, Mo.
B. M. Hopkins, G, Kansas City, Mo.
W. W. Horner, Ac., St. Louis, Mo.
Mrs. W. W. Horner, G, St. Louis, Mo.
Carl L. Howell, Ac., Buffalo, N. Y.
Wm. A. Howell, Ac., Newark, N. J.
P. Hubbard, Ac., New York, N. Y.
S. W. Hume, As., New York City.
Humphrey, G, St. Louis, Mo.

R. O. Jackson, G, St. Louis, Mo.
R. Jablonsky, G, Clayton, Mo.
C. C. Johnson, G, St. Louis, Mo.
Oliver Johnson, G, St. Louis, Mo.

A. L. Kaull, G, St. Louis, Mo.
P. S. Kaull, As., St. Louis, Mo.
Dr. A. L. Kammerer, G, St. Louis, Mo.
Julian Kendrick, Ac., Birmingham, Ala.
D. A. Kennedy, As., Boston, Mass.
L. W. Kemp, As., Houston, Texas
W. H. Kershaw, As., New York City
F. E. Kingsbury, G, St. Louis, Mo.
Miss B. Kinner, G, Conneaut, O.
E. R. Kinsey, Ac., St. Louis, Mo.
L. Kirschbraun, Ac., Chicago, Ill.
C. A. Kitchen, G, St. Louis, Mo.
Felix Kleeberg, Ac., New York City
R. G. Klugman, G. St. Louis, Mo.

L. M. Law, G., New Orleans, La.
Geo. W. Lamson, As., Chicago, Ill.
R. B. Lee, Ac., Hutchinson, Kans.
E. T. Lewis, Ac., Nashville, Tenn.
F. C. Lingenfelter, Ac., Indianapolis, Ind.
Geo. L. Luck, G, Chicago, Ill.
K. Lydecker, E, Cleveland, O.

Carl Magee, G, St. Louis, Mo.
Louis D. Maguolo, G, St. Louis, Mo.
H. L. Maier, Ac., Wilmington, Del.
James Malone, Ac., Sioux City, Ia.
Mrs. James Malone, G, Sioux City, Ia.
Clark R. Mandigo, As., Kansas City, Mo.
P. F. Marmor, G, St. Louis, Mo.
George E. Martin, As., Chicago, Ill.
F. T. Mason, As., Atlanta, Ga.
Porter S. McCormick, As., Baltimore, Md.
J. C. McVea, Ac., Houston, Texas.
Mrs. J. C. McVea, G, Houston, Texas
C. F. Mebus, Ac., Philadelphia, Pa.
Miss Celia Mebus, G, Philadelphia, Pa.
Donald J. Miller, G, St. Louis, Mo.
Henry S. Miller, G, St. Louis, Mo.
J. S. Miller, Jr., As., Maurer, N. J.
Lowell W. Monroe, Ac., Meadville, Pa.
C. E. Murphy, As., New York City.
C. W. Murray, Ac., Miami, Fla.

J. H. Nevitt, Ac., Toronto, Can.

C. L. Newbold, As., St. Louis, Mo.
H. M. Newton, G, St. Louis, Mo.
W. L. Nicholson, G, St. Louis, Mo.
Geo. H. Norton, Ac., Buffalo, N. Y.

Thos. O'Heir, G, Hamilton, Can.
Mrs. Ernest Ohle, G, St. Louis, Mo.
Arthur O'Leary, Ac., St. Louis, Mo.
Leo Osthaus, Ac., St. Louis, Mo.
Mrs. H. Owen, G, St. Louis, Mo.

E. Paffrath, Ac., St. Louis, Mo.
Mrs. F. W. Pape, G, St. Louis, Mo.
E. E. Parker, Ac., Madison, Wis.
C. C. Pashby, G, Memphis, Tenn.
Monroe L. Patzig, Ac., Des Moines, Ia.
Mrs. Monroe L. Patzig, G, Des Moines, Ia.
Langdon Pearse, Ac., Chicago, Ill.
Mrs. Langdon Pearse, G, Chicago, Ill.
R. Pebworth, As., Everett, Mass.
E. H. Peters, As., Chicago, Ill.
Herman Pfeiffer, G, St. Louis, Mo.
Hiram Phillips, G, St. Louis, Mo.
R. L. Phillips, Ac., Meadville, Pa.
Geo. W. Pieksen, G, St. Louis, Mo.
Frank W. Pierson, Ac., Wilmington, Del.
E. W. Pimm, As., Boston, Mass.
C. D. Pollock, Ac., New York City.
H. F. Pomeroy, G, Chicago, Ill.
C. A. Poole, Ac., Rochester, N. Y.
Arthur Pratt, G, New York City.
A. J. M. Proskauer, G, St. Louis, Mo.
H. B. Pullar, As., Lawrenceville, Ill.
Mrs. H. B. Pullar, G, Lawrenceville, Ill.
S. W. Putnam, As., Midland, Mich.

L. Q. Quigley, As., Chicago, Ill.

Edward S. Rankin, Ac., Newark, N. J.
F. A. Reimer, Ac., Newark, N. J.
F. C. Read, As., Baton Rouge, La.
T. H. Reed, As., Jacksonville, Fla.
W. A. Reid, G, Passaic, N. J.
F. F. Rein, G, St. Louis, Mo.
L. E. Rein, G, Chicago, Ill.
John M. Rice, Ac., Pittsburg, Pa.
Douglas Rolfe, G, St. Louis, Mo.
W. E. Rolfe, Ac., St. Louis, Mo.
Mrs. W. E. Rolfe, G, St. Louis, Mo.
James A. Ross, Ac., Trenton, N. J.
J. W. Routh, Ac., Rochester, N. Y.
H. A. Rowland, Ac., McPherson, Kans.
E. G. Rowlands, G, Peoria, Ill.
Wm. A. Ruch, Ac., Allentown, Pa.
C. A. Rudolph, Ac., Wilmington, Del,

R. E. Salveter, G, Webster, Mo.
S. Sammelman, Ac., St. Louis, Mo.
H. G. Saunders, G, Kansas City, Mo.
E. J. Scheme, G, St. Louis, Mo.
H. Von Schrenk, Af., St. Louis, Mo.
Raymond Schuermann, G, St. Louis. Mo.
Miss Schultz, G, St. Louis, Mo.
Meyer Serkes, G, St. Louis, Mo.
Philip Sharples, As., New York City.
F. W. Sheaf, Ac., Rutherford, N. J.
P. K. Sheidler, As., Cincinnati, O.
J. S. Sherman, As., S. Orange, N. J.
E. D. Sherrick, As., Kansas City, Mo.
H. Shiffrin, G, St. Louis, Mo.
J. W. Skelly, G, St. Louis, Mo.
B. M. Smith, As., Chicago, Ill.
Herbert H. Smith, Ac., Brooklyn, N. Y.
H. T. Smutz, G, St. Louis, Mo.
E. T. Sobolenski, Ac., St. Louis, Mo.
W. W. Southgate, Ac., Nashville, Tenn.
Herbert Spencer, As., New York City.
Mrs. H. Spoehrer, G, St. Louis, Mo.
N. S. Sprague, Ac., Pittsburg, Pa.
J. M. States, Ac., St. Louis, Mo.
W. A. Steele, G, St. Louis, Mo.
Jos. A. Stiffelman, Ac., St. Louis, Mo.
Wm. Stoecker, Ac., Webster Groves, Mo.
Mrs. Wm. Stoecker, G, Webster Groves, Mo.
Wm. H. Stone, Af., Baltimore, Md.
O. C. Stupp, G, St. Louis, Mo.
N. J. Stupp, G, St. Louis, Mo.
Thos. F. Sullivan, Ac., Boston, Mass.
John Swan, Ac., Pittsburg, Pa.
D. J. Sweeney, Ac., Buffalo, N. Y.
E. O. Sweetser, G, St. Louis, Mo.

W. M. Taggart, Jr., G, St. Louis, Mo.
Geo. O. Tenny, As., Richmond, Va.
C. F. Thomas, G, St. Louis, Mo.
D. O. Thomas, G, Belleville, Ill.
P. L. Thompson, As., New York City
H. F. Thomson, G, St. Louis, Mo.
Mrs. H. F. Thomson, G, St. Louis, Mo.
Jas. J. Tobin, As., Boston, Mass.
Kurt Toensfeldt, Ac., St. Louis, Mo.
Ralph Toensfeldt, Ac., St. Louis, Mo.
Mrs. K. Toensfeldt, G, St. Louis, Mo.
Geo. W. Tillson, Ac., LaGrange, Ill.
Thomas T. Tracy, G, St. Louis, Mo.
J. C. Travilla, As., St. Louis, Mo.
Mrs. J. C. Travilla, G, St. Louis, Mo.
W. D. Tulley, G, St. Louis, Mo.

R. V. Utter, G, St. Louis, Mo.

Jas. R. Valk, Ac., Chicago, Ill.
Mrs. G. L. Van Ornum, G, St. Louis, Mo.
Isaac Van Trump, Ac., Chicago, Ill.
Henry A. Varney, Ac., Brookline, Mass.
N. T. Veatch, Jr., Ac., Kansas City, Mo.
J. D. Von Maur, Af., St. Louis, Mo.
Miss Evelyn Von Maur, G, Overland, Mo.
Mrs. H. Von Schrenk, G, St. Louis, Mo.

Wm. Wagener, G, St. Louis, Mo.
G. J. Wagner, Ac., Grand Rapids, Mich.
Edward E. Wall, Ac., St. Louis, Mo.
Mrs. Edward E. Wall, G, St. Louis, Mo.
J. T. Ware, As., Kansas City, Mo.
R. M. Watson, Ac., Rutherford, N. J.
R. Weinberger, G, St. Louis, Mo.
H. C. Wenzel, Ac., St. Paul, Minn.
Geo. O. White, As., Memphis, Tenn.
Linn White, Ac., Chicago, Ill.
F. V. Widger, As., Chicago, Ill.
F. R. Wiederholt, G, St. Louis, Mo.
Ellery D. Williams, Ac., St. Louis, Mo.
Roger W. Williams, As., Chicago, Ill.
Mrs. E. D. Williams, G, St. Louis, Mo.
L. A. Wilson, As., Peoria, Ill.
Mrs. L. A. Wilson, G, Peoria, Ill.
S. C. Wilson, G, Boston, Mass.
C. A. Winston, Ac., W. Orange, N. J.
C. A. Wise, Ac., Passaic, N. J.
Edgar P. Withrow, Ac., St. Louis, Mo.
Mrs. Edgar P. Withrow, G, St. Louis, Mo.
J. W. Woermann, G, St. Louis, Mo.
Mrs. J. W. Woermann, G, St. Louis, Mo.
E. E. Wood, As., St. Louis, Mo.
William E. Worcester, G, Philadelphia, Pa.
P. B. Wright, Jr., G, Kansas City, Mo.

The Exhibit Hall at the St. Louis Convention

EXHIBITORS AT ST. LOUIS CONVENTION

American Association of Engineers
The American City
Asphalt Association
Barber Asphalt Company
Barrett Company
Bitoslag Paving Co.
Blackmer & Post Pipe Co.
Bonsack Machinery Company
Central Equipment Co.
Cincinnati Quarries Co.
Dunn Wire Cut Lug Brick Co.

Elgin Sales Corp.
Engineering News-Record
Evens & Howard Fire Brick Co.
Fink Instrument Company
General Motors Truck Co.
Glencoe Lime & Cement Co.
Granite Paving Block Mfrs. Association of United States
Hydraulic Steel Craft Co.
Ideal Power Lawn Mower Co.
Jennison-Wright Co.
The Kinney Mfg. Co.
Koehring Machine Co.
Laclede-Christy Clay Products Co.
Leschen & Sons Rope Co.
Lock-Joint Pipe Co.
Mack International Truck Co.
Manufacturers Record
Portland Cement Association
Public Works
The Texas Company
United Iron Works
Warren Brothers Company
The White Company

OFFICERS OF THE SOCIETY FOR THE YEAR
1920-1921

President	R. KEITH COMPTON	Baltimore, Md.
First Vice-President	EDWARD S. RANKIN	Newark, N. J.
Second Vice-President	W. W. HORNER	St. Louis, Mo.
Third Vice-President	ELLIS R. DUTTON	Minneapolis, Minn.
Secretary	CHARLES C. BROWN	Valparaiso, Ind.
Treasurer	HERMAN H. SMITH	Brooklyn, N. Y.

Finance Committee

FREDERIC A. REIMER, Chairman	Newark, N. J.
L. D. CUTCHEON	Grand Rapids, Mich.
FREDERICK A. DALLYN	Toronto, Ont.

Executive Committee

The officers of the Society, together with the Past Presidents who have retained their continuous membership, constitute the Executive Committee. The names of the Past Presidents are given below.

CONVENTIONS AND PAST PRESIDENTS OF THE SOCIETY

First	1894	Buffalo	M. J. Murphy (deceased), St. Louis
Second	1895	Cincinnati	M. J. Murphy (deceased), St. Louis
Third	1896	Chicago	Geo. H. Benzenberg, Milwaukee
Fourth	1897	Nashville	August Herrmann, Cincinnati
Fifth	1898	Washington	H. Van Duyne (deceased), Newark
Sixth	1899	Toronto	Nelson P. Lewis, New York
Seventh	1900	Milwaukee	A. D. Thompson, Peoria
Eighth	1901	Niagara Falls	Robert E. McMath (deceased) St. Louis
Ninth	1902	Rochester	E. A. Fisher, Rochester
Tenth	1903	Indianapolis	C. H. Rust, Toronto
Eleventh	1904	St. Louis	G. M. Ballard (deceased), Newark
Twelfth	1905	Montreal	A. Prescott Folwell, New York
Thirteenth	1906	Birmingham	Charles C. Brown, Valparaiso
Fourteenth	1907	Detroit	Morris R. Sherrerd, Newark
Fifteenth	1908	Atlantic City	George W. Tillson, LaGrange
Sixteenth	1909	Little Rock	James Owen, Orlando
Seventeenth	1910	Erie	Julian Kendrick, Birmingham
Eighteenth	1911	Grand Rapids	Fred Giddings, Charlotte
Nineteenth	1912	Dallas	E. A. Kingsley, Little Rock
Twentieth	1913	Wilmington	B. E. Briggs, Erie
Twenty-first	1914	Boston	E. H. Christ, Grand Rapids
Twenty-second	1915	Dayton	William A. Howell, Newark
Twenty-third	1916	Newark	A. F. Macallum, Ottawa
None	1917	Convention omitted on account of the war.	
Twenty-fourth	1918	Buffalo	N. S. Sprague, Pittsburg
Twenty-fifth	1919	New Orleans	E. R. Conant, Mansfield
Twenty-sixth	1920	St. Louis	G. H. Norton, Buffalo

R. KEITH COMPTON
President

EDWARD S. RANKIN
First Vice-President

W. W. HORNER
Second Vice-President

ELLIS R. DUTTON
Third Vice-President

CHARLES C. BROWN
Secretary

HERMAN H. SMITH
Treasurer

STANDING COMMITTEES—1920-1921

GENERAL COMMITTEES

1. STREET PAVING, SIDEWALKS AND STREET DESIGN, STREET MAINTENANCE AND STREET RAILWAY CONSTRUCTION.

General Chairman	WILLIAM A. HOWELL,	Newark, N. J.
Sub-Chairman "A"	K. C. KASTBERG	Des Moines, Iowa
Sub-Chairman "B"	E. R. CONANT	Mansfield, Mass.
Sub-Chairman "C"	GEO. H. NORTON	Buffalo, N. Y.
Sub-Chairman "D"	C. A. POOLE	Rochester, N. Y.

Sub-Committee A—Street Paving.

K. C. KASTBERG, *Chairman*	Des Moines, Iowa
W. H. TAYLOR, JR	Norfolk, Va.
H. E. BARNES	Shreveport, La.

Sub-Committee B—Sidewalks and Street Design.

E. R. CONANT, *Chairman*	Mansfield, Mass.
J. B. HITTELL	Chicago, Ill.
P. L. BROCKWAY	Wichita, Kans.

Sub-Committee C—Street Maintenance.

GEO. H. NORTON, *Chairman*	Buffalo, N. Y.
J. A. VANDEWATER	Buffalo, N. Y.
C. J. VAN ETTA	Milwaukee, Wis.

Sub-Committee D—Street Railway Construction.

C. A. POOLE, *Chairman*	Rochester, N. Y.
HENRY MAETZEL	Columbus, Ohio
C. E. HAWKINS	St. Louis, Mo.

2. CITY PLANNING.

General Chairman	HARLAND BARTHOLOMEW	St. Louis, Mo.
Sub-Chairman "A"	NELSON P. LEWIS	New York, N. Y.
Sub-Chairman "B"	JOSEPH W. SHIRLEY	Baltimore, Md.
Sub-Chairman "C"	N. S. SPRAGUE	Pittsburg, Pa.
Sub-Chairman "D"	JOHN M. RICE	Pittsburg, Pa.

Sub-Committee A—Local Sub-Divisions.

NELSON P. LEWIS, *Chairman*	New York, N. Y.
LAWRENCE GRIFFITH	Yonkers, N. Y.
E. A. KINGSLEY	Little Rock, Ark.

Sub-Committee B—Zoning.

JOSEPH W. SHIRLEY, *Chairman*	Baltimore, Md.
J. C. GRINNALDS	Baltimore, Md.
NELSON CUNLIFF	St. Louis, Mo.

Sub-Committee C—Utilities.

N. S. SPRAGUE, *Chairman*	Pittsburg, Pa.
JAMES A. HOOKE	St. Louis, Mo.
F. M. STEWART	Austin, Tex.

Sub-Committee D—Park Systems and Open Spaces.

JOHN M. RICE, *Chairman*	Pittsburg, Pa.
FREDERICK L. OLMSTED	Brookline, Mass.
G. A. PARKER	Hartford, Conn.

3. Traffic and Transportation.

A. H. BLANCHARD, *Chairman*	Ann Arbor, Mich.
ROBERT HOFFMAN	Cleveland, O.
CHARLES O. BOYD	Beckley, W. Va.

4. Street Lighting.

CHARLES W. KOINER, *Chairman*	Pasadena, Calif.
WM. F. SCHWARTZ	Buffalo, N. Y.
T. J. WASSER	Trenton, N. J.

5. Street Cleaning, Refuse Disposal and Snow Removal.

General Chairman	MORRIS R. SHERRERD	Newark, N. J.
Sub-Chairman "A"	A. PRESCOTT FOLWELL	New York, N. Y.
Sub-Chairman "B"	JOHN SWAN	Pittsburg, Pa.
Sub-Chairman "C"	T. F. SULLIVAN	Boston, Mass.

Sub-Committee A—Street Cleaning.

A. PRESCOTT FOLWELL, *Chairman*	New York, N. Y.
WILLIAM F. SCHWARTZ	Buffalo, N. Y.
GEO. D. FAIRTRACE	Dallas, Tex.

Sub-Committee B—Refuse Disposal.

JOHN SWAN, *Chairman*	Pittsburg, Pa.
J. D. TRUSS	Birmingham, Ala.
JOHN CHAMBERS	Louisville, Ky.

Sub-Committee C—Snow Removal.

T. F. SULLIVAN, *Chairman*	Boston, Mass.
J. W. CROWLEY	Davenport, Ia.
S. W. ECKLEY	Peoria, Ill.

6. Sewerage and Sanitation, Public Comfort Stations.

General Chairman	T. C. HATTON	Milwaukee, Wis.
Sub-Chairman "A"	LANGDON PEARSE	Chicago, Ill.
Sub-Chairman "B"	E. A. FISHER	Rochester, N. Y.
Sub-Chairman "C"	H. F. BASCOM	Allentown, Pa.

Sub-Committee A—Sewerage.

LANGDON PEARSE, *Chairman*	Chicago, Ill.
C. M. REPPERT	Pittsburg, Pa.
G. G. EARL	New Orleans, La.

Sub-Committee B—Sanitation, including Sewage Disposal.

E. A. FISHER, *Chairman*	Rochester, N. Y.
KENNETH ALLEN	New York, N. Y.
W. W. HORNER	St. Louis, Mo.

Sub-Committee C—Public Comfort Stations.

H. F. BASCOM, *Chairman*	Allentown, Pa.
WILLIAM B. FOWLER	Memphis, Tenn.
E. S. RANKIN	Newark, N. J.

7. Water Works and Water Supply.

N. S. HILL, Jr., *Chairman*	New York, N. Y.
J. R. BAYLIS	Baltimore, Md.
R. S. WESTON	Boston, Mass.

8. MUNICIPAL LEGISLATION AND FINANCE.

MANLEY OSGOOD, *Chairman*	Ann Arbor, Mich.
W. A. BASSETT	New York, N. Y.
F. L. OLSON	Minneapolis, Minn.

9. FIRE PREVENTION.

GEN. H. N. RUTTAN, *Chairman*	Winnipeg, Man., Canada
E. R. DAVIS	Newport News, Va.
O. J. S. ELLINGSON	Sherman, Texas

10. PUBLIC MARKETS.

D. J. SWEENEY, *Chairman*	Buffalo, N. Y.
C. A. EMERSON, JR	Harrisburg, Pa.
WM. B. MOOREHOUSE	Tarrytown, N. Y.

11. CONVENTION PAPERS.

C. C. BROWN, *Chairman*	Valparaiso, Ind.
R. K. COMPTON	Baltimore, Md.
GEO. W. TILLSON	La Grange, Ill.

12. CONVENTION ARRANGEMENTS.

MAJOR EZRA B. WHITMAN, *Chairman*	Baltimore, Md.
GUSTAV J. REQUARDT, *Assistant Chairman*	Baltimore, Md.

Sub-Committee on Entertainment

BANCROFT HILL, *Chairman*	Baltimore, Md.

Sub-Committee on Exhibits

H. L. ROY CARTER, *Chairman*	Baltimore, Md.

Sub-Committee on Badges

CHARLES F. KUHNS, *Chairman*	Baltimore, Md.

Sub-Committee on Finances

WESLEY HANNA, *Chairman*	Baltimore, Md.

Sub-Committee on Automobiles

JOHN S. BRIDGES, *Chairman*	Baltimore, Md.

Sub-Committee on Reception and Information

GEORGE S. ROBERTSON, *Chairman*	Baltimore, Md.

SPECIFICATIONS COMMITTEES

1. SHEET ASPHALT PAVEMENTS.

HERMAN H. SMITH, *Chairman*	Brooklyn, N. Y.
FRANCIS P. SMITH	New York, N. Y.
EDGAR P. WITHROW	St. Louis, Mo.
LESTER KIRSCHBRAUN	Chicago, Ill.
FELIX KLEEBERG	New York, N. Y.

2. BITUMINOUS MACADAM, BITUMINOUS CONCRETE AND ASPHALT BLOCK PAVEMENTS.

LINN WHITE, *Chairman*	Chicago, Ill.
A. W. DOW	New York, N. Y.
EDGAR P. WITHROW	St. Louis, Mo.
MONROE L. PATZIG	Des Moines, Iowa
THOMAS E. COLLINS	Elizabeth, N. J.

3. BROKEN STONE AND GRAVEL ROADS, WITH OR WITHOUT BITUMINOUS SURFACE TREATMENT.

HARRY F. HARRIS, *Chairman*	Trenton, N. J.
CHARLES A. WINSTON	West Orange, N. J.
THOMAS E. WINN, JR	Winston-Salem, N. C.
D. B. DAVIS	Richmond, Ind.
THOMAS J. WASSER	Trenton, N. J.

4. BRICK PAVEMENTS.

G. F. FISK, *Chairman*	Buffalo, N. Y.
E. B. ULRICH	Reading, Pa.
E. E. DUFF, JR	Pittsburg, Pa.
D. B. DAVIS	Richmond, Ind.
E. A. FISHER	Lakewood, O.

5. CEMENT-CONCRETE PAVEMENTS.

H. ELTINGE BREED, *Chairman*	New York, N. Y.
D. B. DAVIS	Richmond, Ind.
A. B. CUTTER	Everett, Wash.
R. A. MACGREGOR	New York, N. Y.
HARRY F. HARRIS	Trenton, N. J.

6. STONE BLOCK PAVEMENTS.

R. A. MACGREGOR, *Chairman*	New York, N. Y.
JOSHUA ATWOOD	Boston, Mass.
OSCAR CLAUSSEN	St. Paul, Minn.
R. W. WADDELL	Kansas City, Mo.
C. D. POLLOCK	New York City

7. WOOD BLOCK PAVEMENTS.

E. R. DUTTON, *Chairman*	Minneapolis, Minn.
FRED C. DUNLAP	Philadelphia, Pa.
GEORGE CHAMPE	Toledo, Ohio
FRANK V. P. ELLSWORTH	Texarkana, Ark.
GERALD J. WAGNER	Grand Rapids, Mich.

8. SIDEWALKS AND CURBS.

SYLVERIUS SAMMELMAN, *Chairman*	St. Louis, Mo.
E. A. KINGSLEY	Little Rock, Ark.
MONROE L. PATZIG	Des Moines, Ia.
C. E. P. BABCOCK	Buffalo, N. Y.
H. A. ROWLAND	McPherson, Kans.

9. SEWERS.

W. W. HORNER, *Chairman*	St. Louis, Mo.
ALEXANDER POTTER	New York, N. Y.
EDGAR S. DORR	Boston, Mass.
CARL L. HOWELL	Buffalo, N. Y.
WALTER G. KIRKPATRICK	Monroe, La.

10. SUB-GRADE AND FOUNDATIONS.

FRED A. REIMER, *Chairman*	Newark, N. J.
BRUCE ALDRICH	Toronto, Ont.
A. W. DOW	New York, N. Y.
JOHN A. GRIFFIN	Los Angeles, Calif.
H. H. CRAVER	Pittsburg, Pa.

11. STREET RAILWAY PAVEMENTS INCLUDING TRACK CONSTRUCTION.

CHARLES E. DELEUW, *Chairman*	Chicago, Ill.
C. E. HAWKINS	St. Louis, Mo.
HENRY MAETZEL	Columbus, Ohio
W. W. SOUTHGATE	Nashville, Tenn.
M. D. PACE	Troy, Ala.

SPECIAL COMMITTEES

1. STANDARD TESTS FOR BITUMINOUS MATERIALS.

FRANCIS P. SMITH, *Chairman*	New York, N. Y.
M. S. EVANS	Pittsburg, Pa.
PREVOST HUBBARD	New York, N. Y.
LESTER KIRSCHBRAUN	Chicago, Ill.
FELIX KLEEBERG	New York, N. Y.

2. STANDARD TESTS FOR NON-BITUMINOUS MATERIALS.

ARTHUR H. BLANCHARD, *Chairman*	Ann Arbor, Mich.
THOMAS H. BRANNAN	Columbus, Ohio
AUSTIN B. FLETCHER	Sacramento, Calif.
CLARENCE D. POLLOCK	New York, N. Y.
WALLACE L. CALDWELL	Birmingham, Ala.

3. COMMITTEE ON MEMBERSHIP.

J. C. LITTLE, *Chairman*	Baltimore, Md.
CHARLES C. BROWN	Valparaiso, Ind.
PORTER S. McCORMICK	Baltimore, Md.
J. R. BAYLIS	Baltimore, Md.
J. A. DUCHASTEL	Outremont, Que., Canada
E. H. CHRIST	Grand Rapids, Mich.

REPRESENTATIVES IN OTHER ORGANIZATIONS

AMERICAN SOCIETY FOR TESTING MATERIALS

Committee D-4 on Road Materials

HERMAN H. SMITH, *Delegate*	Brooklyn, N. Y.
FRANCIS P. SMITH, *Alternate*	New York City.

Committee C-4 on Clay and Cement Sewer Pipe

W. W. HORNER, *Delegate*	St. Louis, Mo.
ALEXANDER POTTER, *Alternate*	New York City

NATIONAL RESEARCH COUNCIL

Division of Engineering

E. S. RANKIN, *Delegate*	Newark, N. J.
MANLEY OSGOOD, *Alternate*	Ann Arbor, Mich.

NATIONAL SAFETY COUNCIL

ARTHUR H. BLANCHARD, *Delegate*	Ann Arbor, Mich.
CHARLES O. BOYD, *Alternate*	Beckley, W. Va.

MEMBERSHIP LIST

ACTIVE

Ackerman, J. Walter, Chief Engineer and Superintendent of Water, Light and Power, Watertown, N. Y.	1905
Adams, Thomas, Housing and Town Planning Adviser to Canada, Commission of Conservation, 30 Rideau St., Ottawa, Canada	1919
Adler, Julius, Deputy Chief, Bureau of Highways, Philadelphia, Pa	1921
Aldrich, Bruce, District Engineer, the Asphalt Association, 95-97 King St., E., Toronto, Ont.	1919
Aldridge, William, Assistant City Engineer, 333 McGee St., Winnipeg, Manitoba, Canada	1912
Allen, Frank R., 4203 Woodlawn, Pulaski Heights, Little Rock, Ark.	1911
Allen, Henry C., City Engineer, City Hall, Syracuse, N. Y.	1895
Allen, Kenneth, Sanitary Engineer, Board of Estimate and Apportionment, 1235 Municipal Building, New York City	1920
Allin, Thomas D., Allin Brothers, Civil Engineers, 303 Kendall Building, Pasadena, Calif	1905
Ash, Louis R., Harrington, Howard & Ash, Consulting Engineers, Kansas City, Mo.	1911
Askwith, F. C., Deputy City Engineer, 203 Powell Ave., Ottawa, Ont., Can.	1916
Atwood, Joshua, Engineer in Charge Paving Service, 501 City Hall Annex, Boston, Mass	1914
Babcock, C. E. P., First Assistant Engineer, 7 Municipal Building, Buffalo, N. Y.	1914
Baechlin, Ernest, Town Engineer, National Bank Building, Bloomfield, N. J.	1916
Baillarge, W. D., City Engineer, Quebec, Que., Canada	1912
Bair, Maurice Z., Chief Engineer, State Board of Health, Little Rock, Ark.	1920
Baldry, William Earnest, City Engineer, 1106 W. Thirteenth St., Topeka, Kansas	1918
Ball, Edwin, Member of Board of Chosen Freeholders, Newark, N. J	1921
Ballenger, John E., General Manager, D. G. Aronberg & Co., Wallace Block, New Castle, Pa	1913
Barbour, Frank A., Consulting Engineer, 1120 Tremont Building, Boston, Mass	1914
Barlow, James E., City Manager, City Hall, Dayton, Ohio	1910
Barnes, H. E., City Engineer, City Hall, Shreveport, La.	1920
Barnes, J. H., Leslie-Barnes Engineering Company, St. Joesph, Mo.	1918
Barnett, Howard H., City Engineer, City Hall, Pontiac, Mich	1919
Bartholomew, Harland, Engineer City Plan Commission, 231 Municipal Courts Building, St. Louis, Mo	1914
Bartley, John C., Secretary to Superintendent Sewerage and Water Board, 402 Sewerage and Water Board Building, New Orleans, La.	1920
Bartow, Edward, Head of Department of Chemistry, University of Iowa, Iowa City, Iowa	1920
Bascom, H. F., City Engineer, City Hall, Allentown, Pa.	1920
Bastis, Albert, Member City Council Ways and Means and Finance Committees, Minneapolis, Minn	1917
Batson, S. R., City Engineer of Bessemer, 411 N. 30th Street, Birmingham, Ala	1920
Battershill, J. W., Municipal Engineer, Box 15, East Kildonan, Manitoba, Canada	1920
Baylis, J. R., Principal Sanitary Chemist, City Water Department, Montebello Filters, Hillen Road, Baltimore, Md.	1911
Belt, Edwin K., Assistant City Engineer, 525 Woodward Ave., Kalamazoo, Mich	1915
Benham, Webster L., Consulting Engineer, Firestone Building, Kansas City, Mo	1916
Benzenberg, George H., Consulting Engineer, 1018 Wells Building, Milwaukee, Wis	1894

Berthe, L. T., City Engineer, President Berthe Engineering Co., Charleston, Mo.	1917
Bingham, Joseph I., Civil Engineer and Surveyor, 612 Hulett Bldg., Elmira, N. Y.	1919
Blanchard, Arthur H., Professor of Highway Engineering, University of Michigan, Ann Arbor, Mich.	1909
Bohannon, John N., County and Project Engineer, Sandersville, Ga.	1919
Bowden, Lewis G., Member of Board of Chosen Freeholders, Cedar Grove, N. J.	1919
Bowen, L. R., Chief Engineer of Bridges and Buildings, St. Louis, Mo.	1920
Boyd, Charles O., District Highway Engineer, Box 575, Beckley, W. Va.	1920
Brannan, Thomas H., Engineer the Franklin Asphalt Paving Co., 209 S. High St., Columbus, Ohio	1913
Breed, H. Eltinge, Consulting Engineer, Room 600, 507 Fifth Ave., New York City	1921
Brennan, W. C., W. C. Brennan Contracting Co., Hamilton, Ont., Can.	1909
Briggs, B. E. Consulting Engineer, 207 Marine Bank Building, Erie, Pa.	1902
Brockway, P. L., City Engineer, Wichita, Kans.	1918
Brown, Charles Carroll, Consulting Enginneer, Dean of College of Applied Sciences, Valparaiso University, 803 Lincoln Ave., Valparaiso, Ind.	1895
Brown, Guy, Principal Assistant Engineer, Sewer Design, St. Louis, Mo.	1920
Brown, Thurber A., City Engineer, 416 E. Church St., Elmira, N. Y.	1908
Bull, Irving C., Bull & Roberts, 50 West St., New York City	1912
Burden, W. W. Engineer, Department of Sewers and Paving, St. Louis, Mo.	1920
Buswell, A. M., Chief, State Water Survey Division, Urbana, Ill.	1920
Butterfield, Elmore E., In Charge of Laboratory, Boro of Queens, 68 Hunters Point Ave., Long Island City, N. Y.	1921
Butts, C. S., Assistant Engineer, Municipal Bridges, St. Louis, Mo.	1920
Buzby, J. Stewart, Conard & Buzby, Consultants & Engineers, Savings Institution Bldg., Burlington, N. J.	1920

Caldwell, Wallace L., Director Department of Roads and Pavements, Pittsburg Testing Laboratory, 214-250 Clark Bldg., Birmingham, Ala.	1913
Cannon, S. Q., City Engineer, Salt Lake City, Utah	1915
Cappelen, F. W., City Engineer, Minneapolis, Minn.	1895
Carpenter, George A., City Engineer, Pawtucket, R. I.	1905
Carroll, James E., Assistant Chief Engineer and Superintendent of Construction and Repairs, Department of Public Works, 1682 Lincoln Ave., St. Paul, Minn.	1921
Carson, H. O., City Engineer, Central Fire Station, W. North St., Butler, Pa.	1917
Carter, Hugh R., Carter & Knoch, 803 A. O. U. W. Bldg., Little Rock, Ark.	1909
Cellarius, Frederick J., Consulting Engineer, 1001 Commercial Building, Dayton, Ohio	1910
Chambers, John, Chief Engineer, City Hall, Louisville, Ky.	1918
Champe, George, Civil Engineer, 610 Nasby Bldg., Toledo, Ohio.	1920
Charles, Frederick R., Civil Engineer, Richmond, Ind.	1910
Chase, Alden, Engineer of Construction, Sewers and Paving Division, St. Louis, Mo.	1920
Chaussé, Alcide, Hon. Secretary Royal Architectural Institute of Canada, P. O. Box 304, Montreal, Que., Canada	1901
Chivvis, Leland, Engineer of Distribution, Water Division, St. Louis, Mo.	1920
Christ, Edward H., Civil and Consulting Engineer, Norris Building, Grand Rapids, Mich.	1908
Christopher, Edward E., Architect, City Plan Commission, St. Louis, Mo.	1920
Clark, Edward S., City Engineer, Kalamazoo, Mich.	1921
Claussen, Oscar, Chief Engineer, Department of Public Works, City Hall, St. Paul, Minn.	1921
Codwise, Edward B., City Engineer, 298 Wall St., Kingston, N. Y.	1906
Coile, C. E., Engineer for Green Co. Pike Commission and City Engineer, Greenville, Tenn.	1916
Collins, Clarke P., Manager Clarksburg Engineering Company, Inc., 801-2 Goff Building, Clarksburg, W. Va.	1909
Collins, Thomas E., City Engineer, City Hall, Elizabeth, N. J.	1916

Compton, R. Keith, Chairman and Consulting Engineer, Paving Commission, 214 E. Lexington St., Baltimore, Md	1915
Conant, Elbridge R., City Manager, Mansfield, Mass	1913
Cook, J. C., Chief Engineer the J. B. McCrary Co., 1408 Third National Bank Building, Atlanta, Ga	1913
Cooper, C. M., City Engineer, Columbus, Kans	1913
Cornell, Douglas, Structural Engineer and First Assistant to Commissioner of Buildings, 6 Municipal Building, Buffalo, N. Y	1915
Corning, Dudley T., Department of Public Works, Bureau of Street Cleaning, 334 City Hall, Philadelphia, Pa	1909
Corson, S. Cameron, Boro Engineer, City Hall, Norristown, Pa	1908
Costello, James W., Supervising Engineer, Division of Streets, City Hall, Newark, N. J	1919
Cowden, M. B., City Engineer, Harrisburg, Pa	1916
Craig, George W., City Engineer, City Hall, Calgary, Alberta, Can	1911
Crane, Z. G., Member of Board of Chosen Freeholders, West Caldwell, N. J	1921
Craver, H. H., Manager Chemical Department, Pittsburg Testing Laboratory, 616 Grant St., Pittsburg, Pa	1914
Crayton, G. A., Highway Designer, State Highway Commission, Pierre, S. D.	1912
Crecelius, W. E., Assistant Engineer, Bridges and Buildings, St. Louis, Mo	1920
Crosby, Walter W., Consulting Engineer, 307 E. 30th St., Baltimore Md	1909
Crowley, J. W., Commissioner of Public Works, City Hall, Davenport, Iowa	1917
Culverhouse, Harry G., Assistant State Engineer, Bell Building, Montgomery, Ala	1919
Cunliff, Nelson, Chamber of Commerce, Res., 5819 Cates Ave., St. Louis, Mo	1919
Curfman, Lawrence E., City Engineer, 406 W. Adams Ave., Pittsburg, Kans.	1910
Currie, C. H., Consulting Engineer, Webster City, Iowa	1917
Cutcheon, L. D., Secretary and General Manager, Board of Public Works, Grand Rapids, Mich	1906
Cutter, A. B., City Engineer, Everett, Wash	1917
Cutts, F. T., Assistant Water Commissioner, St. Louis, Mo	1920
Dallyn, Frederick A., Provincial Sanitary Engineer, Province of Ontario, Parliament Buildings, Toronto, Ont., Canada	1916
Dalton, E. L., 9-10 Murphy Building, Dallas, Texas	1906
Daly, C. M., Engineer, Water Department, St. Louis, Mo	1920
Darcey, Henry J., State Sanitary Engineer, State Laboratory, 401 East 2d St., Oklahoma City, Okla	1921
Davenport, James H., Member of Board of Chosen Freeholders, 101 Linden Ave., Irvington, N. J	1919
Davis, D. B., City Engineer, Richmond, Ind	1918
Davis, E. Russell, Chief Civil Engineer, Court House, Newport News, Va	1919
Decker, A. Clinton, Mayor, Fairfield, Ala	1920
Delay, Theodore S., Consulting Engineer, Creston, Iowa	1910
DeLeuw, Charles E., City Engineer, Lockport, 1204 Conway Bldg., Chicago, Ill	1920
Dingle, James H., City Engineer, City Hall, Charleston, S. C	1908
Doremus, Goline, Assistant Engineer Department of Streets and Public Improvements, Newark, N. J	1920
Dorr, Edgar, S., Engineer in Charge of Special Work, Sewer Service, 707 City Hall Annex, Res., 213 Savin-Hill Ave., Boston 25, Mass	1914
Doughty, Joshua, Jr., Town and County Engineer, Somerville, N. J	1918
Douthitt, M. J., City Engineer, City Hall, Waukegan, Ill	1911
Dow, A. W., Consulting Engineer, Dow and Smith, 131 E. Twenty-third St., New York City	1899
Drake, W. O., City Engineer and Superintendent Department of Public Works, City Hall, Corning, N. Y	1921
Drinkwater, Ernest, City Engineer, 588 Desaulniers Blvd., St. Lambert, Que.	1918
Drowne, Henry B., 40 Converse St., Long Meadow, Mass	1912
Dubuc, J. H., Consulting Engineer, 187 St. Joseph Blvd., W., Montreal, Que., Canada	1916
Duchastel, J. A., City Engineer, Outremont, Que., Canada	1917

Duck, Allen Douglas, Consulting Engineer, Box 218, Greenville, Tex.	1913
Duff, Edward E., Jr., District Engineer, Eastern Paving Brick Mfrs. Asso., 3402 Schaffer Place, South Hills Sta., Pittsburg, Pa.	1916
Dunlap, Fred C., Chief of Bureau of Highways, City Hall, Philadelphia, Pa.	1915
Durham, Henry Welles, Consulting Engineer, 366 Fifth Ave., New York City, Res., Sandwich, Mass.	1913
Dutton, E. R., Assistant City Engineer, Minneapolis, Minn.	1914
Eager, George, Supervisor of Roads, Essex County, Millburn, N. J.	1916
Eagle, W. H., Superintendent of Municipal Asphalt Plant, City Hall, Columbus, Ohio	1919
Earl, George G., General Superintendent, Sewerage and Water Board, New Orleans, La.	1906
Earle, Roscoe K., City Engineer, 606 E. 8th St., Davenport, Iowa	1920
Eckley, S. W., Commissioner of Public Works, 1305 S. Adams St., Peoria, Ill.	1919
Eddy, Harrison P., Metcalf & Eddy, Consulting Civil Engineers, 14 Beacon St., Boston, Mass.	1914
Edgerly, R. J., City Engineer, Albany, Ga.	1908
Eichelberger, F. O. Engineer, 979 Howard Block, Dayton, Ohio	1915
Ellsworth, Frank VP., Southwestern Engineering Company, Texarkana, Ark.	1908
Emerson, C. A. Jr., Chief Engineer, State Department of Health, Harrisburg, Pa.	1917
Emerson, Lewis A., Secretary-Treasurer Tomlinson Engineering Company, 1002 Loan and Exchange Building, Columbia, S. C.	1920
Erwin, M. C., Sewer Engineer, City Hall, San Antonio, Texas	1908
Evans, M. S., Director of Tests, Department of Public Works, Center and Dethridge Sts., Pittsburg, Pa.	1918
Evinger, Morris I., Davidson Building, Des Moines, Iowa	1918
Fairtrace, George D., City Engineer, Dallas, Texas	1919
Ferebee, James L., Principal Assistant Engineer, Sewerage Commission, City Hall, Milwaukee, Wis.	1921
Filby, E. L., State Sanitary Engineer, State Board of Health, Columbia, S. C.	1921
Finch, B. K., City Engineer, Wilkes-Barre, Pa.	1908
Firth, Joseph, City Manager, West Palm Beach, Fla.	1908
Fisher, E. A., City Engineer, City Hall, Lakewood Ohio	1917
Fisher E. A., Consulting Engineer and Superintendent of City Planning, Rochester, N. Y.	1897
Fisk, George F., Assistant Engineer in Charge of Pavement Construction, Bureau of Engineering, Department of Public Works, 20 Municipal Building, Buffalo, N. Y.	1916
Fitzgerald, John Daniel, Honorable The Minister for Local Government, Education Building, Loftus St., Sydney, N. S. W., Australia	1920
Fletcher, Austin B., State Highway Engineer, Forum Building, Sacramento, Calif.	1912
Folwell, A. Prescott, Editor Public Works, 243 W. Thirty-ninth St., New York City	1901
Ford, George B., Director, City Planning Department, Technical Advisory Corporation, 132 Nassau St., New York City	1920
Fowler, William B., City Engineer, Memphis, Tenn.	1917
Fox, Robert L., Engineer, 37 E. Broad St., Bethlehem, Pa.	1920
Freeman, Harry H., City Manager, City Hall, Kalamazoo, Mich.	1919
Freitas, George H., City Engineer, Modesto, Calif.	1913
Friedrich, Frank X., Commissioner of Streets and Public Improvements, Joliet, Ill.	1921
Frommer, Charles, Acting Chief of Bureau of Surveys, Philadelphia, Pa.	1921
Fuess, W. W., Secretary Northern Road Improvement District, Stuttgart, Ark.	1919
Fugate, Harry C., City Engineer, West Palm Beach, Fla.	1916
Fuller, George W., Consulting Engineer, 170 Broadway, New York City	1906
Gage, Robert B., Chemical Engineer State Highway Commission, Taylor Place, Trenton, N. J.	1920

Gainey, W. H., City Engineer, Valdosta, Ga	1906
Gans, R. C., Engineer, Department of Streets and Sewers, St. Louis, Mo	1920
Garges, S. J., Commissioner of Public Works, City Hall, New Rochelle, N. Y.	1919
Garvin, Edgerton Chester, Resident Engineer Federal Aid Highways and Assistant to Consulting Engineer City Pavements and Sewers, Brunswick, Ga	1919
Gaymon, D. P., City Engineer, Pueblo, Colo	1920
Gaynor, Keyes C., 735 Frances Building, Sioux City, Iowa	1911
Giddings, Fred, Consulting Engineer, 906 East Boulevard, Charlotte, N. C.	1896
Giles, John A., Hoadley and Giles, Civil Engineers, 415 Phelps Bank Building, Binghamton, N. Y	1911
Gillen, Charles P., Mayor, Newark, N. J	1914
Gillespie, Richard H., General Manager Cement Gum Company, Allentown, Pa	1912
Gillette, Halbert, P., Consulting Appraisement Engineer, Editor Engineering and Contracting, 608 S. Dearborn St., Chicago, Ill	1919
Gleason, Joseph A., Deputy Commissioner of Public Property, in Charge of Public Works, New Orleans, La	1918
Goslau, Justus, Chemist to Engineering Department, Newark, N. J	1919
Gottschalk, L. F., Engineer for City and County, Columbus, Neb	1918
Grant, John R., Superintendent of Streets, 306 City Hall, Poeria, Ill	1919
Gray, E. R., City Engineer, Hamilton, Ont., Canada	1916
Greeley, Samuel A., Pearse, Greeley and Hansen, Consulting Engineers, 39 W. Adams St., Chicago, Ill	1919
Green, Howard R., Consulting Engineer, 634-5 Cedar Rapids Savings Bank Building, Cedar Rapids, Iowa	1919
Gregory, John H., Consulting Engineer, Professor of Civil and Sanitary Engineering, The Johns Hopkins University, Homewood, Baltimore, Md	1921
Grier, R. Henry, Director Street and Sewer Department, Wilmington, Del	1919
Griffin, John A., City Engineer, 405 S. City Hall Annex, Los Anegles, Calif	1920
Griffith, Lawrence, City Engineer, City Hall, Yonkers, N. Y	1920
Griggs, Charles E., City Engineer, 212 E. Jasper St., Tulsa, Okla	1919
Grover, Charles M., Member of Board of Chosen Freeholders, 606 Summer Ave., Newark, N. J	1916
Hackney, John W., City Engineer, 141 St. Charles Place, Atlantic City, N. J.	1908
Hadert, John A., New Rochelle, N. Y	1918
Hall, John W., City Engineer and Water Superintendent, Choteau, Mont	1919
Hall, William H., City Engineer, New Britain, Conn	1917
Hamley, S. J., District Manager Pittsburg Testing Laboratory, 242 Rockefeller Building, Cleveland, Ohio	1917
Hammersley, W. P., Town Manager, 18 Marion Ave., Norwood, Mass	1919
Hammond, George T., Consulting Engineer, 156 Berkeley Place, Brooklyn, N. Y	1908
Hansell, William A., Jr., Superintendent of Public Works of Fulton County, 501 County Court House, Atlanta, Ga	1916
Hansen, Paul, Pearse, Greeley & Hansen, Hydraulic and Sanitary Engineers, 39 W. Adams St., Chicago, Ill	1913
Hardy, William G., 1149 Mt. Royal Ave. E., Montreal, Que	1920
Harper, E. F., City Engineer, East St. Louis, Ill	1920
Harris, Harry F., Mercer County Engineer, Trenton, N. J	1910
Harris, R. C., Commissioner of Works, Toronto, Ont., Canada	1914
Harting, O. F., Principal Assistant Engineer, Terminal Association, St. Louis, Mo	1920
Hatton, T. Chalkley, Chief Engineer of Sewerage Commission, Milwaukee, Wis	1903
Hawley, John B., Consulting Engineer, 255 Burton Building, Ft. Worth, Tex.	1912
Hawley, John B., Highway Engineer, U. S. Bureau of Public Roads, 327 Seventh Ave., N., Nashville, Tenn	1917
Heebink, G. E., City Engineer, Goodwin Block, Beloit, Wis	1917
Heimbuecher, W. A. City Engineer, University City, Mo	1920
Helland, Hans, City Engineer, 1109 McCullough Ave., San Antonio, Texas.	1917
Helland H. R. F., City Engineer and Water Superintendent, City Hall, Waxahachie, Tex	1920

Henry, P. W., Room 3700, 120 Broadway, New York City	1920
Hering, Rudolph, Consulting Engineer, 140 W. 69th St., New York City	1910
Herrmann, August, Wiggins Block, Cincinnati, Ohio	1894
Hicks, Lawrence M., Member of Board of Chosen Freeholders, 34 Clinton St., Newark, N. J	1919
Hill, C. D., Engineer, Board of Local Improvements, 207 City Hall, Res., 1730 W. 104th St., Chicago, Ill	1920
Hill, Nicholas, S., Jr., Hill and Ferguson, Consulting Engineers, 112 E. 19th St., New York City	1911
Hills, George B., Engineer Manager, Isham Randolph & Co., Consulting Engineers, 35–38 Barnett Building, Jacksonville, Fla	1913
Hines, Henry C., Member of Board of Chosen Freeholders, 810 Broad St., Newark, N. J	1921
Hittell, John B., District Engineer The Asphalt Association, 29 S. LaSalle St., Chicago, Ill	1908
Hoffman, Robert, Chief Engineer, Department of Public Service, Cleveland, Ohio	1908
Holmes, Harold R., City Engineer, City Hall, Lockport, N. Y	1921
Hooke, James A., Director Public Utilities, St. Louis, Mo	1920
Hoopes, Edgar M., Jr., P. O. Box 895, Wilmington, Del	1915
Hoover, Clarence B., Chemist in Charge, Division of Sewage Disposal, City Hall, Columbus, Ohio	1917
Horner, W. W., Chief Engineer, Sewers and Paving, 300 City Hall, St. Louis, Mo	1915
Howard, J. W., Consulting Paving Engineer and Testing Laboratory, 234 Mt. Prospect Ave., Newark, N. J	1901
Howe, S. B., City Engineer, 220 S. Grange Ave., Sioux Falls, S. D	1920
Howe, Will B., City Engineer, Concord, N. H	1895
Howe, William E., County Engineer, Erie, Kans	1918
Howell, Carl L., 7 Municipal Building, Buffalo, N. Y	1914
Howell, Robert B., Gen. Mgr., Metropolitan Water District, Omaha, Neb	1920
Howell, William A., Engineer, Bureau of Paving, City Hall, Newark, N. J	1907
Hubbard, Prevost, Chemical Engineer the Asphalt Association, 25 W. 43d St., New York City	1913
Hudson, Leo, Consulting Hydraulic and Sanitary Engineer, Box 14, Boston, Allegheny Co., Pa	1911
Hughes, Charles W., Civil Engineer, 2147 Fifth St., Port Arthur, Texas	1920
Hughes, Hector James, Dean of the Harvard Engineering School, Harvard University, Cambridge, Mass	1914
Hull, Walter L., City Engineer, City Hall, Orange, N. J	1920
Hunter, Lionel, McL., Roadway Engineer, City Engineer's Office, 7 Willard Ave., Ottawa, Ont., Canada	1916
Jaudon, H. S., Consulting and Supervising Engineer, Box 582, Elberton, Ga	1920
Jeffries, L. D., City Engineer, 302 City Hall, Peoria, Ill	1918
Jewell, Albert H., Chief Engineer, State Board of Health, Lawrence, Kan	1921
Johnson, George A., George A. Johnson Co., Consulting Engineers, 150 Nassau St., New York City	1917
Jones, Maurice L., City Engineer and Superintendent of Public Works, 368 Washington St., Benton Harbor, Mich	1920
Judson, Clayton O., City Engineer, 1811 Faraon St., St. Joseph, Mo	1919
Judson, H. D., St. Joseph, Mo	1918
Judson, William Pierson, Consulting Engineer, President Broadalbin Electric Light and Power Co., Broadalbin, Fulton, County N. Y	1902
Kastberg, Karl C., Engineer, Box 923, Des Moines, Iowa	1918
Kendrick, Julian W., City Engineer, Birmingham, Ala	1898
Kershaw, G. Bertram, Consulting Engineer, 9 Victoria St., Westminster, London, S. W., England	1918
Kiel, H. W., Mayor, St. Louis, Mo	1920
Kingsley, Edgar A., Highway and Municipal Engineer, 633-4 Southern Trust Building, Little Rock, Ark	1908
Kinsey, E. R., President, Board of Public Service, St. Louis, Mo	1920

Kirkpatrick, Walter G., Municipal and Hydraulic Engineer, Monroe, La	1912
Kirschbraun, Lester, Consulting Engineer, 160 N. Wells St., Chicago, Ill	1909
Kleeberg, Felix, Chemist, Department of Public Works, Municipal Building, New York City	1915
Klyce, B. H., 721 Fourth and First National Bank Building, Nashville, Tenn.	1913
Kneale, Robert D., Consulting Engineer, Georgia School of Technology, Atlanta, Ga	1917
Koiner, C. W., General Manager and Electrical Engineer, Municipal Lighting Works, Pasadena, Calif	1913
Kramer, Xavier A., State Highway Engineer, Magnolia, Miss	1919
Kress, Bancroft, V. P. Roberts Engineering Co., Sanitary Engineers, Ruffner Hotel, Charleston, W. Va	1920
Laberge, F. C., Consulting Engineer, 30 St. James St., Montreal, Que., Can	1915
Lalonde, J. A., Assistant Supt. of Streets of Montreal, 23 Duverger Ave., Outremont, P. Q., Can	1921
Lawrence E. A., Jennings-Lawrence Co., 511-12 Hartman Building, Columbus, Ohio	1915
Lee, B. M., City Engineer, Asheville, N. C	1908
Lee, R. B., City Engineer, 105 First St., E., Hutchinson, Kans	1918
Legare, T. Keith, District Engineer, Dow & Smith, 1327 Main St., Columbia, S. C	1916
Leland, Arthur, Supervisor of Recreation, City Hall, Newport, R. I	1919
Lenderink, Andrew, Consulting Engineer, 501 Kalamazoo National Bank Building, Kalamazoo, Mich	1912
Lewis, E. T., Commissioner of Streets and Sewers, City Hall, Nashville, Tenn.	1921
Lewis, Nelson P., Municipal Building, New York City	1895
Lindeman, Philip, Member of Board of Chosen Freeholders, 53 Osborne Terrace, Newark, N. J	1921
Lindsley, F. O., Member of Board of Chosen Freeholders, 42 Sanford St., East Orange, N. J	1921
Lingenfelter, F. C., City Engineer, City Hall, Indianapolis, Ind	1921
Lingley, Ralph G., Superintendent of Sewer Department, 31 City Hall, Worcester, Mass	1920
Linsley, Charles W., Plant Engineer Oswego Candy Works and Lung's Chocolate Works, Oswego, N. Y	1915
Linville, Ralph K., City Engineer, Danville, Va	1920
Little, John C., The Development & Construction Company, 506 American Building, Baltimore, Maryland	1910
Logan, James, County Engineer, Mt. Holly, N. J	1918
Lovewell, Maurice N., Assistant Engineer, South Park Commission, Fifty-seventh St. and Cottage Ave., Chicago, Ill	1912
Luster, W. H., Elizabeth, N. J	1905
Lutken, P. K., City Engineer, Box 422, Laurel, Miss	1920
Macallum, Andrew F., Commissioner of Public Works, Ottawa, Ont., Canada	1909
MacDonald, James H., Road and Pavement Expert, Temple and Chapel Sts., New Haven, Conn	1914
MacDonald, Walter Elwood, City Water Works Engineer, 21 Fourth Ave., Ottawa, Ont., Canada	1919
MacGregor, R. A., Assistant Engineer, Department of Public Works, Boro of Manhattan, Municipal Building, New York City	1915
Macksey, H. V., Superintendent of Public Works, Framingham, Mass	1921
Maetzel, Henry, Paving Engineer, Street Railway Company, 165 E. Deshler St., Columbus, Ohio	1908
Mahnken, Alfred J., Civil and Constructing Engineer, and Contract Manager, Steneck Building, Hoboken, N. J., 1476 Broadway, New York City	1917
Maier, Harry L., Engineer in Charge of Sewers, Wilmington, Del	1919
Makino, U., Civil Engineer Bureau of Public Works, Japanese Home Department, Tokio, Japan	1919
Malone, James, Department of Streets and Public Improvements, Sioux City, Iowa	1920
Mangold, John F., Armour Institute of Technology, Chicago, Ill	1913

McArthur, Franklin, City Engineer, Guelph, Ont., Canada	1916
McCarthy, P. A., Consulting Engineer and City Engineer, Lufkin, Texas	1917
McClelland, Richard J., City Engineer, Kingston, Ont., Canada	1917
McComb, Dana Quick, Division Engineer, State Highway Department, Nashville, Tenn	1917
McCullough, Ernest, Construction Engineer, 1722 W. Genesee St., Syracuse, N. Y	1909
McElroy, James A., City Engineer, City Hall, Bridgeport, Conn	1920
McKellip, F. W., City Engineer, Faribault, Minn	1918
McKelvey, J. N., Director of Public Safety, St. Louis, Mo	1920
McVea, J. C., City Engineer, Houston, Texas	1919
Meade, R. E., P. O. Box 94, Florence, Ala	1906
Meagher, Michael, Alderman, 1613 Fremont Ave. N., Minneapolis, Minn	1913
Mebus, Chas. F., Albright & Mebus, Consulting Engineers, 907 Land Title Building, Philadelphia, Pa	1920
Mentz, H. A., Principal Assistant Engineer of X. A. Kramer, Magnolia, Miss.	1919
Mercier, Paul E., Consulting Engineer of the Administrative Commission, City Hall, Montreal, Que., Canada	1910
Metz, L. V., Contractor, Erie, Pa	1910
Miller, Chalmers C., City Engineer, City Hall, Lorain, Ohio	1919
Miner, Franklin M., Assistant Engineer, Street Laying Out Department, 404 City Hall Annex, Boston, Mass	1913
Mitchell, Lequin, City Manager, Lufkin, Tex	1919
Monroe, Lowell W., Assistant City Engineer, Meadville, Pa	1921
Montgomery, Julian, City Engineer, Wichita Falls, Texas	1920
Morales, Luis, Consulting Engineer, Architect and General Contractor, Aguiar No. 84, Havana, Cuba. Residence, F entre 13 y 15-Vedado, Havana, Cuba	1917
Morrison, Roger L., Engineer of Tests Pittsburg Testing Laboratory, 216 Clark Building, Birmingham, Ala	1914
Morse, Robert Brooks, Chief Engineer State Department of Health and of Washington Suburban Sanitary District, 16 W. Saratoga St., Baltimore, Md	1921
Moseley, Hal., Commissioner of Streets and Public Property, Dallas Texas	1915
Mullen, Charles A., Consulting Paving Engineer, Director of Paving Department, Milton Hersey Co., Ltd., 84 St. Antoine St., Montreal, Que., Can.	1911
Mungle, William, Member of Board of Chosen Freeholders, 640 Ridge St., Newark, N. J	1921
Murray, Charles W., City Engineer, Miami, Fla	1918
Myers, William G., City Engineer, Harrisonburg, Va	1916
Near, W. P., City Engineer, St. Catharine, Ont., Canada	1915
Nevitt, J. H., Engineer in Charge of Main Sewage Disposal, 348 Lake Front, Toronto, Ont	1920
Noble, O. E., Municipal Engineer, Norton, Kans	1908
Norton, George H., City Engineer, 20 Municipal Building, Buffalo, N. Y	1914
Nutting, H. C., Manager Pittsburg Testing Laboratory, Oskamp Building, Cincinnati, Ohio	1919
Oakes, Henry G., City Engineer, Muskegon Heights, Mich	1920
Ogden, Henry N., Professor of Sanitary Engineering, Cornell University, Ithaca, N. Y	1909
O'Leary, Arthur L., Commissioner of Streets and Public Improvements, East St. Louis, Ill	1920
Olmsted, Frederick L., Landscape Architect, Brookline, Mass	1909
Osgood, Manley, Ann Arbor Asphalt Construction Co., 716 National Bank Building, Ann Arbor, Mich	1914
Osthaus, Leo, Assessor of Special Taxes, St. Louis, Mo	1920
Overland, Arthur B., City Engineer, Austin, Minn	1919
Owen, James, 504 Lake St., Orlando, Fla	1898
Pace, M. D., City Engineer, Troy, Ala	1920
Paffrath, Ernest, Assistant Engineer, Sewers and Paving, St. Louis, Mo	1920
Painter, Pennell C., City Engineer, Washington, N. C	1921

Pape, F. W., Park Commissioner, St. Louis, Mo	1920
Parent, Arthur, Superintendent of City Lighting Department, Montreal, Que. Canada	1905
Parker, E. E., City Engineer, Madison, Wis	1917
Parker, G. A., Secretary and Treasurer State Park Commission, Superintendent of Parks, Municipal Building, Hartford, Conn	1902
Patzig, Monroe L., Consulting Paving Engineer, 680 Forty-fourth St., Des Moines, Iowa	1918
Pearse, Langdon, Sanitary Engineer, the Sanitary District of Chicago, 910 S. Michigan Ave., Chicago, Ill	1919
Peck, Leon F., Superintendent of Streets, Municipal Building, Hartford, Conn	1913
Pendleton, Henry H., City Engineer, 620 S. Main St., Independence, Mo	1918
Phillips, Roy L., City Engineer, Meadville, Pa	1919
Phul, William von, Member of Ford, Bacon & Davis, President and General Manager United Railroads of San Francisco, 58 Sutter St., San Francisco, Cal	1911
Pierce, Herbert W., Commissioner of Public Works, 26 City Hall, Rochester, N. Y	1914
Pierce, James S., Mayor, Dunkirk, N. Y	1919
Pierson, Frank W., Secretary Board of Directors, Street and Sewer Department, Wilmington, Del	1915
Pitzman, Julius, City Surveyor, St. Louis, Mo	1920
Pollard, Seabury Gould, Consulting Water Supply Engineer, 3422 Burch Ave., Cincinnati, Ohio	1915
Pollock, Clarence D., Pollock and Taber, Consulting Engineers, Park Row Building, New York City	1902
Poole, C. Arthur, City Engineer, City Hall, Rochester, N. Y	1918
Porter, John L., Director Water Purification Stations, 8407 Panola St., New Orleans, La	1919
Potter, Alexander, Consulting Civil Engineer, 50 Church St., New York City	1913
Pratt, Charles, City Engineer and Superintendent of Water Works, Chanute, Kans	1918
Proctor, Edward M., James, Proctor and Redfern, Consulting Engineers, 36 Toronto St., Toronto, Ont	1920
Rankin, E. S. Engineer in Charge, Bureau of Sewers, City Hall, Newark, N. J.	1903
Ray, Clare M., City Engineer, Kokomo, Ind	1920
Raymond, T. L., Director Department of Streets and Public Improvements, City Hall, Newark, N. J.	1919
Reed, Tom M., Assistant Chief Engineer Streets, Playgrounds and Parks, 17 E. Lacock St., Pittsburg, Pa	1918
Reimer, Frederic A., County Engineer Essex County, Court House, Newark, N. J	1909
Reppert, Charles M., Chief Engineer Bureau of Engineering, Department of Public Works, 421 City-County Building. Res. 6324 Bartlett Ave., Pittsburg, Pa	1908
Reynolds, A. M., Chief Engineer of Essex County Park Commission, 115 Clifton Ave., Newark, N. J	1908
Rice, John M., Engineer, 411 Oliver Building, Pittsburg, Pa	1918
Richards, H. S., Superintendent of Maintenance and Repairs, South Park Commissioners, 6930 Constance Ave., Chicago, Ill	1909
Ridgway, Robert, Engineer of Subway Construction, Transit Construction Commission, 49 Lafayette St., New York City	1908
Ridley, Clarence E., Romeo, Mich	1919
Rogers, Niart, City Engineer, Asbury Park, N. J	1909
Rolfe, W. E., Associate to President, Board of Public Service, St. Louis, Mo	1920
Root, Joseph E., Sewerage Engineer, Department of Public Service, Delaware Building, Akron, Ohio	1915
Ross, James A., County Supervisor of Roads, 4 Southard St., Trenton, N. J	1919

Tarvia
Preserves Roads
Prevents Dust

Tarvia Service
"On the Job" Every Minute

The Tarvia Service Department offers a mighty helpful service to road engineers, contractors and city authorities. It is manned by highway engineers of long experience, and provided with special apparatus of various kinds for handling Tarvia to the best possible advantage.

In many sections of the country the Tarvia Department can provide automobile-tank service that brings the Tarvia hot from the works or from the tank-cars and delivers it on the job promptly and economically.

In fact, if you want *real co-operation and service* in your road work, call on the Tarvia Department of The Barrett Company. Write, wire or telephone our nearest office and let us know how we can help you. We are ready to serve you.

The Barrett Company

New York Chicago Philadelphia Boston St. Louis Cleveland Cincinnati Pittsburgh Detroit New Orleans Birmingham Kansas City Minneapolis Dallas Nashville Syracuse Salt Lake City Seattle Peoria Atlanta Duluth Milwaukee Bangor Washington Johnstown Lebanon Youngstown Toledo Columbus Richmond Latrobe Bethlehem Elizabeth Buffalo Baltimore Omaha Houston Denver Jacksonville
THE BARRETT COMPANY, Limited: Montreal Toronto Winnipeg Vancouver St. John, N. B. Halifax, N. S. Sydney, N. S.

Routh, James W., Director of Bureau of Municipal Research, 25 Main St., E. Rochester, N. Y.	1916
Rowland, H. A., City Engineer, McPherson, Kans.	1917
Ruch, William A., Commissioner of Highways, City Hall, Allentown, Pa.	1920
Rudolph, Charles A., 900 Van Buren St., Wilmington, Del.	1912
Russell, G. Raymond, 1624 Stimson Ave., Rosedale, Kans.	1915
Rust, Charles H., Toronto Electric Light Co., 12 Adelaide St., E., Toronto, Ont., Canada	1898
Ruttan, H. N., Brigadier General (retired), Consulting Engineer, 180 Westgate, Winnipeg, Man., Canada	1904
Sammelman, Sylverius, Principal Assistant Chief Engineer, Sewers and Paving, Department of the President, Board of Public Service, 300 City Hall, St. Louis, Mo.	1915
Sargent, George H., City Engineer, LaGrange, Ga.	1918
Sarver, William Edward, City Engineer, Canton, Ohio	1915
Sawyer, Walter H., Sawyer and Bean, Hydraulic Engineers, 11 Lisbon St., Lewiston, Me.	1918
Schmoll, John, Director of Public Welfare, St. Louis, Mo.	1920
Schott, A. M., Engineer, Sioux City, Iowa	1920
Schwartz, William F., Street Commissioner, 64 Franklin St., Buffalo, N. Y.	1919
Schweizer, Rudolph, Village Engineer, 20 Edwin St., Ridgfield Park, N. J.	1920
Seward, Jr., Oscar A., City Engineer and Chief Engineer of Wharf and Dock Commission, Beaumont, Tex.	1921
Shaner, H. L., Commissioner of Public Works, City Hall, Winston-Salem, N. C.	1908
Sheaf, Fred W., Mayor, Rutherford, N. J.	1917
Shelton, William H., City Engineer, 617 Central Ave., Dunkirk, N. Y.	1916
Shepard, Frank T., Town Engineer of Belleville, 352 Center St., Nutley, N. J	1920
Sherrerd, Morris R., Chief Engineer, Department of Streets and Public Improvements, City Hall, Newark, N. J.	1896
Simonds, Fred W., City Manager, Elizabeth City, N. C.	1919
Simpson, Arthur J., Engineer Bureau of Docks, Department of Streets and Public Improvements, City Hall, Newark, N. J.	1920
Slater, J. M., Street Commissioner, St. Louis, Mo.	1920
Slattery, John L., Secretary-Treasurer St. Johns Municipal Council, St. Johns, Newfoundland	1901
Smith, Francis P., Consulting Engineer, Dow and Smith, 131-133 E. Twenty-third St., New York City	1908
Smith, Herman H., Chief Engineer Bureau of Highways, Room 502, 50 Court St., Brooklyn, N. Y.	1915
Smith J. J., Engineer, Widlund Block, Grand Forks, N. D.	1913
Smythe, Edward, Superintendent of Garbage Collection, 410 Persimmon St., Peoria, Ill.	1918
Snyder, Frederick Antes, Commonwealth Water Company, 105 Carnegie Ave., East Orange, N. J.	1914
Sobolewski, E. F., Principal Assistant Engineer Paving Design, St. Louis, Mo.	1920
Southgate, W. W., City Engineer, City Hall, Nashville, Tenn.	1920
Sprague, Norman S., Engineer, 808–10 Wabash Building, Pittsburg, Pa.	1908
Starks, W. Fred, County Superintendent of Highways, Glen Cove, N. Y.	1917
Steed, Robert E., City Clerk, P. O. Box 919, Norfolk, Va.	1911
Stevenson, John D., Engineer Division of Bridges, 1231 Monterey St., N. S., Pittsburg, Pa.	1912
Stevenson, W. L., Assistant Chief Engineer, State Department of Health, Harrisburg, Pa.	1918
Stiffelman, Joseph, Engineer of Maintenance Street Department, St. Louis, Mo.	1920
Stoecker, William, Engineer of Maplewood and Webster Groves, St. Louis, Mo.	1920
Stone, Sam, Jr., Commissioner of Public Property, New Orleans, La.,	1919
Storrie, William, Consulting Civil Engineer, 625 Confederation Life Building, Toronto, Ont.	1920

Mixed asphalt and clay mastic cast, excavated at Lagash near the mouth of the Euphrates, which dates back to 2850 B. C.

As Far Back As Knowledge Extends

As early as 3000 B. C., asphalt was used as a cementing medium or binder for attaching small objects or ornaments to sculptures, carvings and pottery.

Later, Nabopolasser, King of Babylon, used asphalt as a filler or mortar for brick pavements. His son, Nebuchadnezzer, next used asphalt as a mortar in the construction of brick walls and foundations.

It is a far cry from an ancient Babylonian roadway to modern and beautiful Fifth Avenue—yet both have been indebted to asphalt for much of the fame, beauty and durability which rank them as leaders in their respective periods of history.

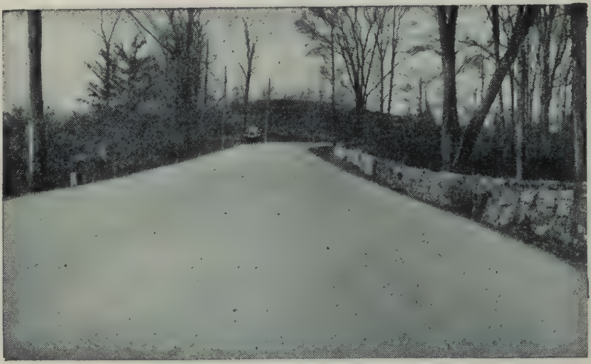
The uses of asphalt are being steadily extended and production and application of the material are being simplified. Through centuries of time asphalt has been subjected to countless tests and uses. It is the inevitable solution of the paving problem.

Send for Brochures, Circulars and Specifications

THE ASPHALT ASSOCIATION
25 WEST 43d ST.
CHICAGO NEW YORK TORONTO

ASPHALT
Proved through the Ages

Sullivan, Thomas F., Commissioner of Public Works, 509 City Hall Annex, Boston, Mass	1919
Swan, John, Director Department of Public Works, City-County Building, Pittsburg, Pa	1919
Sweeney, Daniel J., City Clerk, City Hall, Buffalo, N. Y	1920
Sylvester, Elbert W., Poughkeepsie, N. Y	1913
Talbert, C. M., Director of Streets and Sewers, St. Louis, Mo	1920
Talbot, A. N., Professor of Municipal and Sanitary Engineering, University of Illinois, Urbana, Ill	1896
Taplin, Arthur E., Consulting Engineer, Box 423, High Point, N. C	1917
Taylor, W. H., Jr., Director of Public Works, Norfolk, Va	1917
Thomas, E. J., City Engineer, Minot, N. D	1919
Thum, William, 123 Columbia St., Pasadena, Calif	1912
Tillson, George W., Consulting Engineer, 313 S. Catherine Ave., LaGrange, Ill	1897
Toensfeldt, Kurt, Engineer Water Department, St. Louis, Mo	1920
Toensfeldt, Ralph, Engineer Division of Lighting, St. Louis, Mo	1920
Tomlinson, W. S., City Engineer, Columbia, S. C	1921
Tremblay, Thomas, City Engineer, 30 Peel St., Sherbrooke, Que	1919
Tribus, Louis L., Tribus and Massa, Consulting Engineers, 15 Park Row, New York City	1908
Truss, J. D., Commissioner of Public Improvements, 7827 Underwood Ave., Birmingham, Ala	1917
Turner, J. W., Consulting Highway Engineer, Lakeland, Fla	1917
Tuska, Gustave R., Consulting Engineer, 68 William St., New York City	1915
Uhler, William D., Chief Engineer, State Highway Department, Harrisburg, Pa	1914
Ulrich, Edmund B., City Engineer, Reading, Pa	1914
Vandewater, J. A., 7 Municipal Building, Buffalo, N. Y	1914
Van Duyne, Harrison R., Deputy Chief Engineer, City Hall, Newark, N. J	1920
Van Etta, C. J., Superintendent of Street Construction and Repair, Department of Public Works, 705 39th St., Milwaukee, Wis	1919
Van Trump, Isaac, Consulting Asphalt Engineer, 2337 S. Paulina St., Chicago, Ill	1911
Varney, Henry A., Town Engineer, 25 Town Hall, Brookline, Mass	1916
Vars, Alexander, City Engineer, 814 Webster Place, Plainfield, N. J	1916
Veatch, Jr., N. T., Black and Veatch, Consulting Engineers, Mutual Building, Kansas City, Mo	1920
Vincent, J. P., Assistant City Engineer, Hutchinson, Kans	1918
Von Zuben, Frank J., Baker and Von Zuben, Municipal Engineers and Surveyors, Ft., Worth, Tex	1912
Waddell, Robert W., City Engineer, City Hall, Kansas City, Mo	1918
Wagner, Gerald J., City Engineer, 539 Jefferson Ave., S. E., Grand Rapids, Mich	1919
Wagner, Joseph C., Assistant Director Department of Public Works, Philadelphia, Pa	1921
Wakenhut, Paul G., City Engineer, Salina, Kans	1920
Wall, Edward E., Water Commissioner, St. Louis, Mo	1920
Walters, R. Earle, Boro Engineer, Municipal Building, Tarentum, Pa	1920
Warden, Herman, Chairman of Library Board, Pasco, Wash	1920
Wasser, Thomas J., State Highway Engineer, Trenton, N. J	1913
Watson, Robert M., Boro Engineer, Rutherford, N. J	1908
Weaver, H. J., City Engineer, Elkhart, Ind	1918
Weber, B. B., City Engineer, City Building, Oil City, Pa	1917
Webster, Edwin R., Consulting Engineer, 412 Webster Building, 327 S. LaSalle St., Chicago, Ill	1916
Weirbach, Charles D., 708 North 6th St., Allentown, Pa	1916
Weller, W. Earl, City Engineer, 16 Davis St., Binghamton, N. Y	1916
Wells, John J., Civil and Consulting Engineer, Rocky Mount, N. C	1921



Standard Asphalt Binder "B"

STANDARD Refined
Mexican Asphalt
(Socony Brand)
for Sheet Asphalt Paving

Contains approximately 99.5% of pure bitumen, which does not precipitate under any condition. Our refining process insures an absolutely uniform product of proper consistency.

Standard Asphalt Macadam Binders A, B and C
Standard Asphalt Road Oils
Standard Paving Flux
Standard Fillers for Brick and Block Pavements
Standard Asphalt and Preserving Oil
Standard Cold Patch Asphalt

SO NY SOCONY ASPHALTS AND ROAD OILS

Specifications and all other particulars furnished upon request

STANDARD OIL CO. OF NEW YORK
Road Oil Dept. **26 Broadway, New York**

Wentworth, Russell A., Civil Engineer, Expert on Valuations, Curtis Block, Batavia, N. Y.	1918
Wenzel, Herman C., Commissioner of Public Works, 301 Court House, St. Paul, Minn.	1920
Weston, Robert Spurr, Weston and Sampson, Consulting Engineers, 14 Beacon St., Boston, Mass.	1914
White, Jr., Charles E., Commissioner of Public Works, Municipal Building, Oak Park, Ill.	1920
White, Linn, Chief Engineer, South Park Commissioners, Chicago, Ill.	1908
Willey, Marney B., Assistant Engineer, K. C. Gaynor Company, 527 Trimble Building, Sioux City, Iowa. Mail to Woodburn, Iowa	1919
Williams, E. D., Sewers and Paving Division, St. Louis, Mo.	1920
Willigerod, W. S., City Engineer, City Hall, East Orange, N. J.	1913
Willis, T. L., City Engineer, New Orleans, La.	1919
Wingfield, Nisbet, Consulting Engineer, 812-5 Lamar Building, Augusta, Ga.	1906
Winn, Thomas E., Jr., Engineer in Charge of Paving Construction, Alexander Apartments, W. 4th St., Winston-Salem, N. C.	1919
Winston, Charles A., Town Engineer, Town Hall, West Orange, N. J.	1920
Wise, B. A., City Engineer, Bradford, Pa.	1916
Wise, Colin R., City Engineer, 301 Gregory Ave., Passaic, N. J.	1915
Withrow, Edgar P., Engineer in Charge of Municipal Testing Laboratory, 55 Municipal Courts Building, St. Louis, Mo.	1918
Woermann, John W., U. S. Assistant Division Engineer, 428 Custom House, St. Louis, Mo.	1920
Wolfinger, Wellington R., Assistant Construction Engineer, State Highway Department, 1548 Powell St., Norristown, Pa.	1918
Woodward, Arthur H., Deputy Superintendent of Streets, City Hall, Springfield, Mass.	1919
Wynne-Roberts, R. O., Consulting Engineer, 40 Jarvis St., Toronto, Ont.	1918

MUNICIPAL MEMBERS AND THEIR DELEGATES

Allentown, Pa.
H. F. Bascom
W. A. Ruch

Beaumont, Tex.
O. A. Seward, Jr.

Binghamton, N. Y.
W. Earl Weller

Buffalo, N. Y.
C. E. P. Babcock
Douglas Cornell
G. F. Fisk
C. L. Howell
G. H. Norton
W. F. Schwartz
J. A. Vandewater

Canada, Dominion of
Commission of Conservation
Thomas Adams

Chanute, Kan.
Charles Pratt

Danville, Va.
R. K. Linville

Elizabeth, N. J.
Thomas E. Collins

Elkhart, Ind.
H. J. Weaver

Essex County, N. J.
Edwin Ball
Lewis G. Bowden
Z. G. Crane
James H. Davenport
George Eager
Charles M. Grover
Lawrence M. Hicks
Henry C. Hines
Philip Lindeman
F. O. Lindsley
William Mungle

Everett, Wash.
A. B. Cutter

Faribault, Minn.
F. W. McKellip

Guelph, Ont.
Franklin McArthur

Harrisburg, Pa.
M. B. Cowden

Houston, Tex.
J. C. Mc Vea

Illinois, State of
Water Survey Division
A. M. Buswell

Kalamazoo, Mich.
H. H. Freeman

Kansas City, Mo.
Robert W. Waddell

Prodding Mules' Hoofs

and

Grinding Iron Wheels

Are

Burdens Endured by

TEXACO

TEXACO Asphaltic Concrete Pavement in Coahoma County, Miss.
Built by the Murray Construction Company in 1920.

TEXACO ASPHALT REG. U.S. PAT. OFF.

The Texas Company

ASPHALT SALES DEPARTMENT

TEXACO ASPHALT REG. U.S. PAT. OFF.

17 Battery Place New York City

New York
Philadelphia
Richmond
Boston

Jacksonville
Tampa
New Orleans
Memphis

Chicago
Cleveland
Oklahoma City
Kansas City

Houston
Des Moines
Minneapolis
Wichita

LOS ANGELES, CAL.
John A. Griffin

LOUISVILLE, KY.
John Chambers

LUFKIN, TEX.
Lequin Mitchell

MEMPHIS, TENN.
W. B. Fowler

MINNEAPOLIS, MINN.
Albert Bastis
Fred W. Cappelen
Ellis R. Dutton
M. Meagher

MONTREAL, QUE.
Paul E. Mercier
Arthur Parent

NEWARK, N. J.
James W. Costello
Charles P. Gillen
Justus Goslau
William A. Howell
Edward S. Rankin
T. L. Raymond
Morris R. Sherrerd

NEW ORLEANS, LA.
J. A. Gleason
Sam Stone, Jr.
T. L. Willis

NEW ROCHELLE, N. Y.
S. J. Garges

NEW SOUTH WALES, AUSTRALIA
J. D. Fitzgerald

NORFOLK, VA.
R. E. Steed
W. H. Taylor, Jr.

NORRISTOWN, PA.
S. Cameron Corson

NORWOOD, MASS.
W. P. Hammersley

OMAHA, NEB.
Robert B. Howell

ONTARIO, PROVINCE OF
F. A. Dallyn

PASADENA, CAL.
C. W. Koiner

PASCO, WASH.
Herman Warden

PAWTUCKET, R. I.
George A. Carpenter

PEORIA, ILL.
S. W. Eckley
J. R. Grant
L. D. Jeffries
Edward Smythe

PHILADELPHIA, PA.
Julius Adler
Fred C. Dunlap
Charles Frommer
Joseph C. Wagner

PONTIAC, MICH.
Howard H. Barnett

POUGHKEEPSIE, N. Y.
Elbert W. Sylvester

QUEBEC, QUE.
W. D. Baillargé

READING, PA.
Edmund B. Ulrich

ROCHESTER, N. Y.
Herbert W. Pierce

RUTHERFORD, N. J.
F. W. Sheaf

ST. JOHNS, NEWFOUNDLAND.
John L. Slattery

SALT LAKE CITY, UTAH
Sylvester Q. Cannon

TORONTO, ONT.
R. C. Harris

WASHINGTON COUNTY, GA.
John N. Bohannon

WILKES-BARRE, PA.
B. K. Finch

WILMINGTON, DEL.
R. H. Grier
H. L. Maier
F. W. Pierson

AFFILIATED

Adam, Carl F., Consulting Engineer, 834 Union Oil Building, Los Angeles, Calif.	1914
Anderson, Earl A., Illuminating Engineer, Nela Park, East Cleveland, O.	1920
Ballinger, Walter F., Ballinger and Perrot, Architects and Engineers, 17th and Arch Sts., Philadelphia, Pa.	1918
Bassett, W. A., Bureau of Municipal Research, 261 Broadway, New York City	1918
Brazer, Clarence W., Architect, 1133 Broadway, New York City, and Crozer Building, Chester, Pa.	1919

Compressed Stone Base for Warrenite Bitulithic Pavement

This form of base has been thoroughly and successfully tested for many years under widely varying climatic and subsoil conditions, and has proven eminently satisfactory, including over 200 miles on the Columbia River Highway, Oregon, shown in illustration below.

COLUMBIA RIVER HIGHWAY, PORTLAND, ORE.
Warrenite-Bitulithic Surfacing Over Old Macadam Sandy Road. Approach to the Columbia River Highway at Sandy River Bridge

SERVICE AND QUALITY

The essential features in laying of Warrenite-Bitulithic.

We furnish expert laboratory service with every pavement laid. The result is shown by the phenomenal growth of Warrenite-Bitulithic.

INSIST ON THE WARREN WAY

Illustrated booklet on Compressed Stone Base furnished upon request as well as other features of Warrenite-Bitulithic.

WARREN BROTHERS COMPANY

Executive Offices: 9 Cambridge St., Bowdoin Sq., Boston, Mass.

DISTRICT OFFICES:

Utica, N. Y.
New York, N. Y.
Portland, Ore.
Vancouver, B. C.
St. Louis, Mo.
Chicago, Ill.
Phoenix, Ariz.
Toronto, Ont.
Minneapolis, Minn.
Washington, D. C.
San Francisco, Cal.
Winnipeg, Man.
Memphis, Tenn.
Richmond, Va.
Los Angeles, Cal.

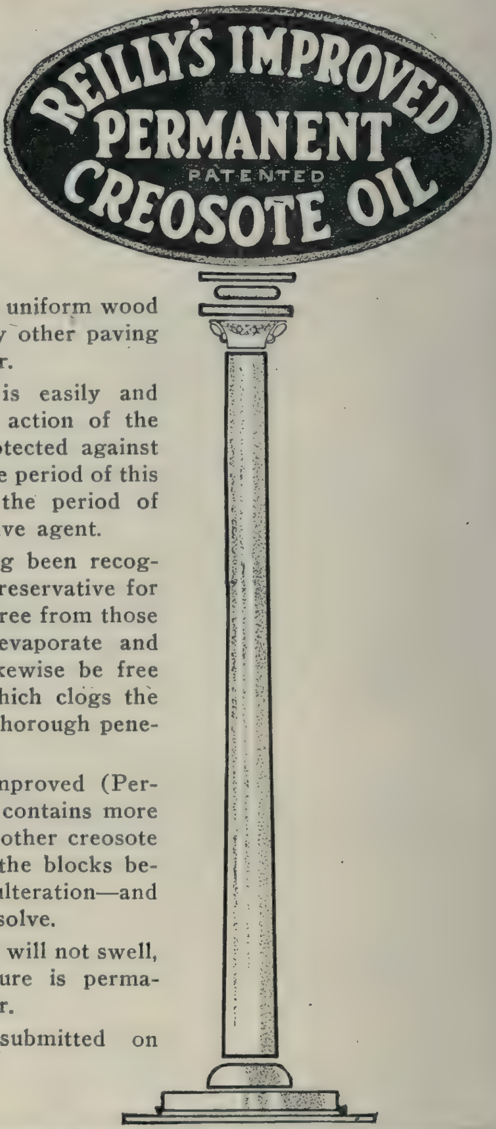
Campbell, John, Superintendent Special Service Department, the Edison Electric Illuminating Co., 39 Boylston St., Boston, Mass.	1913
Cross, Roy, Kansas City Testing Laboratory, 1013 Grand Ave., Kansas City, Mo.	1918
Diel, Charles H., Secretary, Municipal Development Bureau, Chamber of Commerce, St. Louis, Mo.	1920
Dodds, J. T., Vice-President, Mound City Trust Co., St. Louis, Mo.	1920
Emerson, Frank N., Chairman City Planning Committee of Association of Commerce, Peoria, Ill.	1918
Farey, F. O., Robert W. Hunt and Co., McGill Building, McGill St., Montreal, Que.	1918
Follin, James W., Staff Engineer, Bureau of Municipal Research, 805 Franklin Bank Building, Philadelphia, Pa.	1921
French, R. DeL., Lecturer on Civil Engineering, McGill University, Chief Engineer Lignite Utilization Board of Canada, 80 St. Francois Xavier St., Montreal, Que., Canada	1915
Gay, W. L., Chief Engineer, Southern Clay Manufacturing Co., Chattanooga, Tenn.	1920
Hadden, Samuel C., Editor, Municipal and County Engineering, 702 Wulsin Building, Indianapolis, Ind.	1920
Hawkins, C. L., Engineer Way and Structures, United Railways Co., 3869 Park Ave., St. Louis, Mo.	1920
Hidden, Edward, Banker, A. G. Edwards & Sons, St. Louis, Mo.	1920
Johnson, Helen M., Director, Municipal Reference Bureau, Galesburg, Ill.	1921
Lothrop, G. W., Woonsocket, R. I.	1913
Masury, Alfred F., Chief Engineer and Vice-President, International Motor Co., Sixty-fourth St. and West End Ave., New York City	1917
Olson, F. L., Director of Municipal Research, Civic and Commerce Association, Minneapolis, Minn.	1919
Parlin, R. W., Manager, Public Works Department, International Motor Co., 252 W. 64th St., New York City	1920
Roberts, C. W., Secretary Chamber of Commerce, Bristol, Tenn.-Va.	1919
Schaefer, R. O., Editor Southern Construction News, Bye Building, Little Rock, Ark.	1919
Schutt, Harold G., 425 W. 118 th St., New York City	1921
Shakman, James G., Consulting Engineer with Walter H. Flood, 5013 Grand Boulevard, Chicago, Ill.	1916
Sheldon, A. E., Director of Nebraska Legislative Reference Bureau, University of Nebraska, Lincoln, Neb.	1919
Sheridan, Lawrence V., Engineer, Dallas Property Owners Association, City Planning Engineer, 1107 Dallas County State Bank Bldg., Dallas, Texas	1915
Sowers, Don C., Director Bureau of Municipal Research, 423 Second National Bank Building, Akron, Ohio	1919
Spoehrer, Herman, Secretary Union Electric Light and Power Co., St. Louis, Mo.	1920
Stewart, Frank M., Secretary of Bureau of Municipal Research and Reference, Instructor in Government, University of Texas, Austin, Texas	1919
Stone, William H., Associate Editor Manufacturers' Record, Baltimore, Md.	1919
Turin, Capt. F. E., Director, Membership and Publicity, Convention and Publicity Bureau, St. Louis, Mo.	1920
Von Maur, J. D., Engineer of Distribution, Laclede Gas Co., St. Louis, Mo.	1920
Von Schrenk, Hermann, Consulting Timber Engineer, Tower Grove and Flad Aves., St. Louis, Mo.	1914

ASSOCIATE

Ahrens, Jr., H. F., Rep., Lock Joint Pipe Co., P. O. Box 21, Ampere, N. J.

Alley, Harvey L., Sales Engineer, Rep., Warren Brothers Company, 9 Cambridge St., Boston, Mass.

No Wood Block Pavement Can Last Longer Than Its Preservative Element



A new pavement of sound, uniform wood blocks is superior to every other paving material in every particular.

But wood, unprotected, is easily and quickly destroyed by the action of the elements. It must be protected against moisture and decay, and the period of this protection is limited by the period of efficiency of the preservative agent.

Pure creosote oil has long been recognized as the one perfect preservative for wood blocks. It must be free from those volatile elements which evaporate and dissolve. And it must likewise be free from free carbon (tar) which clogs the wood pores and prevents thorough penetration of the oil.

Such an oil is Reilly's Improved (Permanent) Creosote Oil. It contains more permanent body than any other creosote oil—it cannot bleed from the blocks because it contains no tar adulteration—and it cannot evaporate or dissolve.

Blocks treated with this oil will not swell, because the wood structure is permanently sealed against water.

Standard specifications submitted on request.

Invented—Patented—Manufactured and Sold Exclusively by

Republic Creosoting Company

Indianapolis, Indiana

Plants: Indianapolis Minneapolis Seattle Mobile

AMBURSEN CONSTRUCTION COMPANY, INC., 186 Fifth Ave., New York City 1921
- S. W. Stewart, President, 186 Fifth Ave., New York City.

AMERICAN CAR SPRINKLER COMPANY, 1 Brussels St., Worcester, Mass 1917
- E. D. Perry, Asst. Genl. Supt., Box 414, Worcester, Mass.

AMERICAN CITY, THE, 154 Nassau St., New York City 1913
- Edgar J. Buttenheim, President, 154 Nassau St., New York City.

AMERICAN TAR PRODUCTS COMPANY, Chicago, Ill 1921
- Wallace E. Crowell, Athletic Club, Columbus, O.

Anderson, A. M., Secretary-Treasurer, Rep. Elgin Sales Corporation, 1340 Old Colony Building, Chicago, Ill.

ASPHALT ASSOCIATION, THE, 25 W. 43rd St., New York City 1919
- J. E. Pennybacker, Secretary, 25 W. 43rd St., New York City.

ASPHALT SALES CORPORATION, 128 N. Wells St., Chicago, Ill 1921
- H. J. Gillum, President, 128 N. Wells St., Chicago, Ill.

ATLANTIC BITULITHIC COMPANY, 1205 Virginia Railway and Power Building, Richmond, Va 1913
- George O. Tenney, President, 1205 Virginia Railway and Power Building, Richmond, Va.

Bailey, John M., Secretary, Rep. Pittsburg Testing Laboratory, 7th and Bedford Aves., Pittsburg, Pa.

Baker, H. B., Rep., The Holt Mfg. Co., Peoria, Ill.

Baker, W. D., Rep., Warner-Quinlan Asphalt Co., 79 Wall St., New York City.

BARBER ASPHALT PAVING COMPANY, THE, Land Title Building, Philadelphia, Pa 1913
- C. N. Forrest, Maurer, N. J.
- W. H. Howland, 137 Brunswick St., Newark, N. J.
- J. Strother Miller, Jr., Chief Chemist, Technical Department, Maurer, N. J.
- J. E. Morris, Manager Street and Road Department, Land Title Building, Philadelphia, Pa.
- Clifford Richardson, 1615 Woolworth Building, New York City.
- E. C. Wood, St. Louis, Mo.

Barbour, J. G., Sec., Rep. Metropolitan Paving Brick Co., Canton, Ohio.

Barrett, R. R., Engineer of Eastern Division, Rep. The Texas Co., Asphalt Department, 1904 Whitehall Building, 17 Battery Place, New York City.

BARRETT COMPANY, THE, 17 Battery Place, New York City 1906
- Walter Buehler, Engineer of Paving and Wood Preservation, 10 S. LaSalle St., Chicago, Ill.
- C. L. Campbell, 705 LaClede Gas Bldg., St. Louis, Mo.
- W. H. Caruthers, Manager, Paving Department, 705 LaClede Gas Bldg., St. Louis, Mo.
- John A. Hull, Manager Warren Chemical and Manufacturing Division, 17 Battery Place, New York City.
- Geo. E. Martin, Highway Engineer, 10 S. LaSalle, St. Chicago, Ill.
- Philip P. Sharples, Manager General Tarvia Department, 17 Battery Place, New York City.
- P. K. Sheidler, Manager Paving Department, Cleveland, O.
- B. M. Smith, Manager Paving Department, 10 S. LaSalle St., Chicago, Ill.

Benedict, E. L., Vice-President and Manager of Sales, Rep. National Steel Fabric Co., 1st National Bank Building, Pittsburg, Pa.

BIRMINGHAM SLAG COMPANY, 1607 Jefferson County Bank Building, Birmingham, Ala 1920
- C. E. Ireland, Sales Manager, 1607 Jefferson County Bank Building, Birmingham, Ala.
- S. G. Reynolds, Atlanta Branch Manager, 84 Marietta St., Atlanta, Ga.

Blackmer, A. E., Second Vice-President and Sales Manager, Rep. Blackmer and Post Pipe Co., Boatmen's Bank Building, St. Louis, Mo.

KREOLITE LUG WOOD BLOCKS

"The Paving That's Saving"

Note how the lugs provide a spacing around each block. This spacing allows the Kreolite filler to penetrate to the full depth of the blocks, and when laid on a smoothly finished concrete foundation with a Kreolite pitch cushion, seals the blocks on five of their six sides, making a thoroughly waterproof, wearproof construction.

This spacing also gives horses a chance to get a footing and provides a grip for automobile wheel chains.

The lugs prevent bulging or buckling of the pavement, they compress when the blocks expand and relieve the pressure. Because the pressure is relieved, the Kreolite oil will not be forced from the pores of the wood, or "bleed."

"The lugs make a good block better."

THE JENNISON-WRIGHT COMPANY

Kreolite Building TOLEDO, OHIO

BLACKMER AND POST PIPE COMPANY, 1026 Boatmen's Bank Building, St. Louis, Mo. 1912
A. E. Blackmer, Second Vice-President and Sales Manager, Boatmen's Bank Building, St. Louis, Mo.
Blair, Will P., Vice-President, Rep. National Paving Brick Manufacturers' Association, 828-34 B. L. E. Building, Cleveland, O.
BOOTH BROTHERS AND HURRICANE ISLE GRANITE COMPANY, 208 Broadway, New York City 1917
Charles Mitchell, Treasurer, New York City.
Bramley, M. F., Pres. Rep. Cleveland Trinidad Paving Co., 886 The Arcade, Cleveland, Ohio.
Buehler, Walter, Engineer of Paving and Wood Preservation, Rep., The Barrett Co., 17 Battery Place, New York City.
Burns, Howard, E., Rep. Superior Garbage Incinerator Company of Texas, Praetorian Building, Dallas, Texas.
Buttenheim, Edgar J., Pres., Rep. The American City, 154 Nassau St., New York City.

Campbell, C. L., Rep., The Barrett Company, 705 Laclede Gas Bldg., St. Louis, Mo.
CANADA CRUSHED STONE CORPORATION, Ltd., Dundas, Ont. 1919
C. M. Doolittle, Dundas, Ont.
CARSON PETROLEUM COMPANY, 208 S. LaSalle St., Chicago, Ill. 1920
James R. Valk, Manager Asphalt and Road Oil Department, 208 S. LaSalle St., Chicago, Ill.
Caruthers, W. H., Rep., The Barrett Company, 705 Laclede Gas Bldg., St. Louis, Mo.
Cassidy, J. A., Secretary-Treasurer, Rep. Southern Asphalt Association, 419 Healey Building, Atlanta, Ga.
CINCINNATI QUARRIES COMPANY, 108 Bell Block, Cincinnati, Ohio. 1921
Geo. W. Doran, Pres., 108 Bell Block, Cincinnati, O.
Clark, James D., Assistant to Vice-President, Rep. Standard Oil Company of Kentucky, Louisville, Ky.
CLAY PRODUCTS ASSOCIATION, 913 Chamber of Commerce, Chicago, Ill. 1918
G. H. Tefft, Secretary and General Manager, 913 Chamber of Commerce, Chicago, Ill.
CLEVELAND TRINIDAD PAVING COMPANY, 886 The Arcade, Cleveland, Ohio 1915
M. F. Bramley, Pres., 886 The Arcade, Cleveland, Ohio.
CONSTANTINE CONSTRUCTION COMPANY, 240 Dewey Ave., Buffalo, N. Y. 1919
John S. Constantine, President, 240 Dweey Ave., Buffalo, N. Y.
Constantine, John S., Pres., Rep. Constantine Construction Co., 240 Dewey Ave., Buffalo, N. Y.
Craven, William D., Jr., Engr., Asphalt Paving and Road Construction, Rep., Standard Oil Company (New York) Room 1306, 26 Broadway, New York City.
CRESSY ROAD SPRAYER MANUFACTURING COMPANY, 462 Second St., Everett, Mass. 1920
Richard R. Pebworth, Pres., 462 Second St., Everett, Mass.
Crowell, W. E., Rep., American Tar Products Co., Athletic Club, Columbus, O.
Cutter, Frank G., Rep. Warren Brothers Co., Assistant to President, 848 Otis Building, Chicago, Ill.

DeBerard, W. W., Western Editor, Rep., Engineering News-Record, 1570 Old Colony Bldg., Chicago, Ill.
Dickey, W. S., Rep. W. S. Dickey Clay Manufacturing Company, 200 New York Life Building, Kansas City, Mo.

**Modern Traffic Demands
Strong, Durable Roadways
Such as VITRIFIED BRICK**

***The Best Vitrified
Paving Brick Is***

WIRE-CUT LUG

Factories in Twelve States

Free Advisory Engineering Service if Requested

Write for Data and List of Licensed Manufacturers

The Dunn Wire-Cut Lug Brick Co.
Conneaut, Ohio

DICKEY CLAY MANUFACTURING COMPANY, 200 New York Life Bldg., Kansas City, Mo. 1921
W. S. Dickey, President, 200 New York Life Bldg., Kansas City, Mo.

D'Olier, William L., Chief Engineer, Rep. The Sanitation Corporation, 1533 Girard Ave., Philadelphia, Pa.
Donelson, J. E., Rep. Warren Brothers Company, Birmingham, Ala.
Doolittle, C. M., Rep. Canada Crushed Stone Corporation, Dundas, Ont.
Doran, George W., Pres., Rep., The Cincinnati Quarries Co., 108 Bell Block, Cincinnati, O.

DORR COMPANY, THE, 101 Park Ave., New York City 1920
J. S. Sherman, Chief Municipal Sewage Section, 101 Park Ave., New York City.

DOW CHEMICAL COMPANY, THE, Midland, Mich 1920
S. W. Putnam, Midland, Mich.

Draney, J. R., General Sales Manager, Rep. The U. S. Asphalt Refining Co., 90 West St., New York City.
Dunn, Frank B., Pres., Rep. Dunn Wire-cut Lug Brick Co., Conneaut, Ohio.

DUNN WIRE-CUT LUG BRICK COMPANY, Conneaut, Ohio 1911
Frank B. Dunn, President, Conneaut, Ohio.
J. C. Travilla, Consulting Engineer, Room 1018, 211 N. 7th St., St. Louis, Mo.

DUSTOLINE FOR ROADS COMPANY, Summit, N. J 1917
Edwin R. Lamson, President, Summit, N. J.

Duty, Spencer M., Pres., Rep. Medal Paving Brick Co., 16220 Saranac Rd., Cleveland, Ohio.

EASTERN CLAY PRODUCTS ASSOCIATION, 514-5 Pittsburg Life Bldg., Pittsburg, Pa 1920
H. T. Shelley, 514–5 Pittsburg Life Bldg., Pittsburg, Pa.

EASTERN PAVING BRICK MANUFACTURERS' ASSOCIATION, Lincoln Building, Philadelphia, Pa 1920
W. C. Perkins, Secretary, 412 Lincoln Building, Philadelphia, Pa.

Ege, C. R., Engineer Road Bureau, Rep., Portland Cement Association, 111 W. Washington St., Chicago, Ill.
Elder, R. M., Assistant Superintendent Mid-West Division, Rep. The Texas Company, 540 Otis Building, Chicago, Ill.

ELGIN SALES CORPORATION, 1340 Old Colony Building, Chicago, Ill . . . 1920
A. M. Anderson, Secretary-Treasurer, 1340 Old Colony Building, Chicago, Ill.

ENGINEERING NEWS-RECORD, 10th Ave. and 36th St., New York City 1920
R. K. Tomlin, Managing Editor, 10th Ave., and 36th St., New York City
W. W. DeBerard, Western Editor, 1570 Old Colony Building, Chicago, Ill.

Fay, Frank T., Sales Agent Road Oil Dept., Rep. Standard Oil Co. of New York, 50 Congress St., Boston, Mass.
Ferguson, W. C., President, Rep. Ferguson Segment Block Company, 1802 Arcade Building, St. Louis, Mo.

FERGUSON SEGMENT BLOCK COMPANY, 1802 Arcade Building, St. Louis, Mo 1919
W. C. Ferguson, President, 1802 Arcade Building, St. Louis, Mo.

Filbert, C. B. Manager of Sales, Rep., New Orleans Refining Co., 309 Maison Blanche Annex, New Orleans, La.
Fisher, Henry, Manager Road Oil Department, Rep. Standard Oil Company of New York, Room 600, 26 Broadway, New York City.
Fletcher, Herbert E., Pres., Rep. Hildreth Granite Co., West Chelmsford, Mass.
Forrest, C. N., Manager Technical Department, Rep. The Barber Asphalt Paving Co., Maurer, N. J.
Fulweiler, W. H., Chemist, Rep. The United Gas Improvement Co., 1706 N. Broad St., Philadelphia, Pa.

When You Decide

ON

GRANITE

FOR

PAVING OR CURBING

You Settle the Problem

FOREVER

GRANITE PAVING BLOCK MANUFACTURERS' ASSOCIATION OF THE
UNITED STATES, INC.

JAMES J. TOBIN, FIELD ENGINEER
31 STATE STREET
BOSTON

Gartland, Jr., John J., Superintendent Eastern Division, Rep. The Texas Co., Asphalt Sales Dept., Whitehall Building, 17 Battery Place, New York City.
Gillum, H. J., Pres., Rep., Asphalt Sales Corporation, 128 N. Wells St., Chicago, Ill.
GRANITE PAVING BLOCK MANUFACTURERS' ASSOCIATION OF THE UNITED STATES, 31 State St., Boston, Mass............... 1915
J. J. Tobin, Secretary, 31 State St., Boston, Mass.
F. T. Mason, Central Building, Atlanta, Ga.
Greenough, Maurice B., Secretary, Rep. National Paving Brick Mfrs. Assn., 830 B. L. E. Building, Cleveland, Ohio.

HARRIS GRANITE QUARRIES COMPANY, Salisbury, N. C.......... 1915
R. G. Hunt, Drawer 267, Salisbury, N. C.
HASTINGS PAVEMENT COMPANY, 25 Broad St., New York City...... 1920
P. L. Thompson, Sales Manager, 25 Broad St., New York City.
Head, James M., Attorney, Rep., Warren Brothers Co., 9 Cambridge St., Boston, Mass.
Helm, J. S., Rep., Standard Oil Co. of Louisiana, Whitney Central Bldg., New Orleans, La.
Hempelmann, W. L., Engineer of Middle West Division, Rep. The Texas Co., Asphalt Dept., 540 Otis Building, 10 S. LaSalle St., Chicago, Ill.
Hess, Lawrence E., Rep. Republic Creosoting Company, Merchants Bank Building, Indianapolis, Ind.
Hicks, Smith D., Rep., The Rodd Co., Century Building, Pittsburg, Pa.
Hildreth, H. V., General Manager, Rep. Hildreth Granite Co., 31 State St., Boston, Mass
HILDRETH GRANITE COMPANY, 31 State St., Boston Mass.......... 1914
H. V. Hildreth, General Manager, 31 State St., Boston, Mass.
Herbert E. Fletcher, President, West Chelmsford, Mass.
Hirsch, Allan M., Pres., Rep. Lock Joint Pipe Co., P. O. Box 21, Ampere, N. J.
HOLT MANUFACTURING COMPANY, THE, Peoria, Ill............... 1920
H. B. Baker, Peoria, Ill.
Horn, J. Merrick, Rep. Warren Brothers Co., Ford Building, Wilmington, Del.
Howland, William H., 137 Brunswick St., Newark, N. J.
Hull, John A., Manager Warren Chemical and Mfg., Div., Rep. The Barrett Co., 17 Battery Place, New York City.
Hunt, R. G., Rep. Harris Granite Quarries Co., Drawer 267, Salisbury, N. C.

IDEAL POWER LAWN MOWER COMPANY, Lansing, Mich........... 1920
E. H. Peters, Manager Chicago Branch, 533 S. Dearborn St., Chicago, Ill.
Ireland, C. E., Sales Manager, Rep. Birmingham Slag Company, 1607 Jefferson County Bank Building, Birmingham, Ala.

Jennison, H. G., Pres., Rep. The Jennison-Wright Co., 2463 Broadway, Toledo, Ohio.
JENNISON-WRIGHT COMPANY, THE, 2463 Broadway, Toledo, Ohio.. 1914
H. G. Jennison, President, 2463 Broadway, Toledo, Ohio.
Johnson, Alfred H., President, Rep. Texas Bitulithic Company, Praetorian Building, Dallas, Texas.
Johnson, A. N., Consulting Highway Engineer, Rep., Portland Cement Association, University of Maryland, Dean of Engineering College, College Park, Md.

Kaull, Pardon S., Vice-President, Rep. Warren Brothers Company, Railway Exchange Building, St. Louis, Mo.
Kelly, J. M., Secretary, Rep., The Sanitation Corporation, 12th & Monmouth Sts., Jersey, City, N. J.

Where a strong, tough granite is available

DURAX

Embodies all the desirable features of a modern pavement. It is

PERMANENT	SANITARY
SMOOTH	NOT SLIPPERY
NOISELESS	ECONOMICAL TO LAY

NO MAINTENANCE

Full information gladly sent on request

Harris Granite Quarries Company

Salisbury, N. C.

Standard Granite Paving Blocks—Specify Balfour Granite

We invite attention to our special facilities for furnishing all kinds of help on short notice, and especially do we solicit patronage of R. R. Companies, R. R. Contractors, Sewer Contractors, or where a large or small crew of men is required.

Arrangements have been perfected whereby we can fill orders for laborers in large as well as small numbers, especially those of foreign birth, and orders received for this class of help will be given prompt attention and every effort put forth to give satisfaction.

We also solicit patronage of manufacturers and others desiring skilled labor, which we will endeavor to supply promptly on application, as our facilities for furnishing good mechanics are unequalled, such as tradesmen of all classes.

In conclusion, please permit us to say our method of doing business is based strictly upon honest and square dealing with our patrons, and once favored with an order, we feel sure that you will have no occasion to go elsewhere.

Diamond Labor Supply Co.

557 West Madison Street
CHICAGO, ILL.

Phone Main 5074

Kemp, Louis W., Superintendent Southwestern Division, Asphalt Sales Department, Rep., The Texas Company, Houston, Texas.
Kennedy, Dennis A., Superintendent of New England Division, Rep. The Texas Co., Asphalt Dept., 714 Tremont Bldg., 73 Tremont St., Boston, Mass.

KENTUCKY ROCK ASPHALT COMPANY, Paul Jones Building, Louisville, Ky. 1920
Rodman Wiley, Chief Engineer, Paul Jones Building, Louisville, Ky.

Kershaw, W. H., Manager, Rep. The Texas Co., Asphalt Dept., 1904 Whitehall Bldg., 17 Battery Place, New York City.

Lamson, Edwin R., Pres., Rep. Dustoline for Roads Co., Summit, N. J.

LAMSON, GEORGE W., 811 Railway Exchange Bldg., Chicago, Ill. 1911
George W. Lamson, 811 Railway Exchange Bldg., Chicago, Ill.
Roger W. Williams, 811 Railway Exchange Bldg., Chicago, Ill.

Larkin, A. E., Rep. Republic Creosoting Co., 828 Plymouth Bldg., Minneapolis, Minn.
Leopold, J. L., Rep. J. Leopold & Co., 233 Broadway, New York City.

LEOPOLD & COMPANY, J., 233 Broadway, New York City. 1915
J. L. Leopold, 233 Broadway, New York City.

Lewis, F. J., Pres., Rep. F. J. Lewis Mfg. Co., 2500 S. Robey St., Chicago, Ill.

LEWIS MANUFACTURING COMPANY, F. J., 2500 S. Robey St., Chicago, Ill.
F. J. Lewis, President, 2500 S. Robey St., Chicago, Ill.

Libberton, J. H., Manager Service Bureau, Rep. Universal Portland Cement Company, 210 S. LaSalle St., Chicago, Ill.
Lippincott, J. H., Rep. Warren Bros. Co., 50 Church St., New York City.

LOCK JOINT PIPE COMPANY, P. O. Box 21, Ampere, N. J. 1908
Allan M. Hirsh, President, P. O. Box 21, Ampere, N. J.
H. F. Ahrens, Jr., P. O. Box 21, Ampere, N. J.

Mackendrick, W. G., President, Rep. Warren Bituminous Paving Company, Toronto, Ont., Canada.
Mandigo, Clark R., Engineer, Rep. Western Paving Brick Manufacturers' Association, 317 Dwight Building, Kansas City, Mo.
Manning, F. L., General Manager, Rep., Peebles Paving Brick Company, Portsmouth, Ohio.
Marker, J. R., Secretary, Rep. Ohio Paving Brick Manufacturers Association, 507 Hartman Building, Columbus, Ohio.
Martin, George E., Highway Engineer, Rep. The Barrett Company, 10 S. LaSalle St., Chicago, Ill.
Mason, Frank T., Rep., Granite Paving Block Manufacturers Association, Atlanta Trust Building, Atlanta, Ga.

MAYER, G. W., Highway Engineer Imperial Oil Co., 56 Church St., Toronto, Ont., Can. 1921

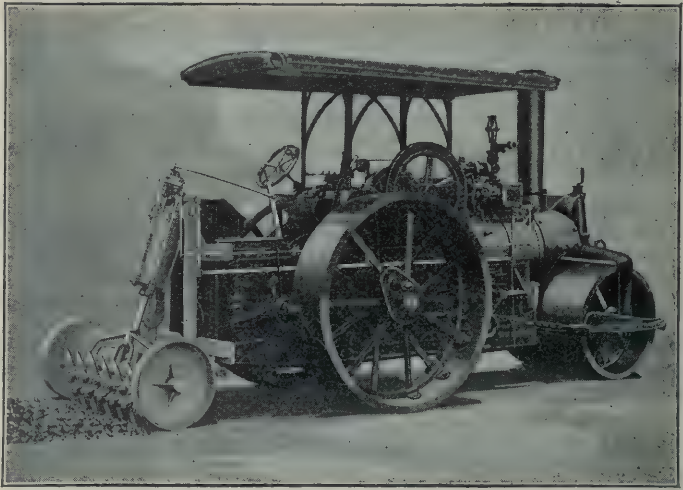
McCormick, Porter S., Asphalt Rep., Standard Oil Company (New Jersey), Baltimore, Md.
McNeil, Donald, Rep. Donald McNeil Company, Jenkins Arcade Building, Pittsburg, Pa.

McNEIL COMPANY, DONALD, Jenkins Arcade Building, Pittsburg, Pa. . 1915
Donald McNeil, Jenkins Arcade Building, Pittsburg, Pa.

MEDAL PAVING BRICK COMPANY, THE, 16220 Saranac Rd., Cleveland, Ohio. 1911
Spencer M. Duty, President, 16220 Saranac Rd., Cleveland, Ohio.

METROPOLITAN PAVING BRICK COMPANY, THE, Canton, Ohio. . . 1911
J. G. Barbour, Secretary, Canton, Ohio.

Miller, Jr., J. Struther, Chief Chemist Technical Dept., Rep., The Barber Asphalt Paving Co., Maurer, N. J.
Mitchell, Charles, Treas., Rep. Booth Bros. and Hurricane Isle Granite Co., 208 Broadway, New York City.



BUFFALO-PITTS and KELLY-SPRINGFIELD ROLLERS now as ever the standard of excellence in roller construction.

Built in all types and sizes.

Steam and Motor driven.

Buffalo-Springfield Pressure Scarifiers are indispensable for economical maintenance work. They can be attached in the field to rollers already in service.

Inquiries invited.

BUFFALO-SPRINGFIELD ROLLER COMPANY

Springfield, Ohio

Our rollers with scarifiers have been adopted by St. Louis County and City.

Morris, J. E., Manager Street and Road Department, Rep. The Barber Asphalt Paving Co., Land Title Building, Philadelphia, Pa.
Murphy, Charles E., Rep. The Texas Company, 17 Battery Place, New York City.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION, 828-834 Brotherhood of Locomotive Engineers' Bldg., Cleveland, Ohio 1907
  Will P. Blair, Vice-President, 828-34 B. L. E. Bldg., Cleveland, Ohio.
  Maurice B. Greenough, Secretary, 830 B. L. E. Bldg., Cleveland, Ohio.
  O. W. Renkert, President, Renkert Building, Canton, O.
NATIONAL STEEL FABRIC COMPANY, First National Bank Building, Pittsburg, Pa. 1920
  E. L. Benedict, Vice-President and Manager of Sales, First National Bank Building, Pittsburg, Pa.
Newbold, C. L., Rep., Warren Brothers Company, 1859 Railway Exchange Bldg., St. Louis, Mo.
NEW ORLEANS REFINING COMPANY, INC., 309 Maison Blanche Annex, New Orleans, La. 1920
  C. B. Filbert, Manager of Sales, 309 Maison Blanche Annex, New Orleans, La.
NEW YORK TRAP ROCK CORPORATION, 101 Park Ave., New York City 1918
  Mortimer D. Wandell, Vice-President, 101 Park Ave., New York City.

OHIO PAVING BRICK MANUFACTURERS' ASSOCIATION, 507 Hartman Building, Columbus, Ohio 1919
  J. R. Marker, Secretary, 507 Hartman Building, Columbus, Ohio.

PACIFIC FLUSH TANK COMPANY, 4241 E. Ravenswood Ave., Chicago, Ill. and Singer Building, New York City.
  E. L. Walcott, 4241 Ravenswood Ave., Chicago, Ill.
Pebworth, Richard R., Pres., Rep., Cressy Road Sprayer Mfg. Co., 462 Second St., Everett, Mass.
PEEBLES PAVING BRICK COMPANY, Portsmouth, Ohio 1912
  F. L. Manning, General Manager, Portsmouth, Ohio.
Pennybacker, J. E., Secretary, Rep. The Asphalt Association, 25 W. 43rd St., New York City.
Perkins, G. Howard, Assistant to President, Rep., Warren Bros. Co., 9 Cambridge St., Boston, Mass.
Perkins, W. C., Secretary, Rep. Eastern Paving Brick Manufacturers' Association, 412 Lincoln Building, Philadelphia, Pa.
Perry, E. D., Assistant General Superintendent, Rep. American Car Sprinkler Company, Box 414, Worcester, Mass.
Peters, E. H., Manager, Chicago Branch, Rep. Ideal Power Lawn Mower Co., 533 S. Dearborn St., Chicago, Ill.
PIONEER ASPHALT COMPANY, Lawrenceville, Ill.
  H. B. Pullar, Vice-President, Lawrenceville, Ill.
PITTSBURG FILTER AND ENGINEERING COMPANY, Farmers' Bank Building, Pittsburg, Pa.
PITTSBURG TESTING LABORATORY, 7th and Bedford Aves., Pittsburg, Pa.
  John M. Bailey, Secretary, 7th and Bedford Aves., Pittsburg, Pa.
PORTLAND CEMENT ASSOCIATION, 111 W. Washington St., Chicago, Ill. 1919
  C. R. Ege, Engineer Road Bureau, 111 Washington St., Chicago, Ill.
  A. N. Johnson, Consulting Highway Engineer, Dean Engineering College, College Park, Md.
Pullar, H. B., Vice-President and General Manager, Rep. Pioneer Asphalt Company, Lawrenceville, Ill.
Putnam, S. W., Rep., The Dow Chemical Co., Midland, Mich.

Modern Sewage Treatment

SANITATION R-W PROCESS

North

NEW YORK CITY

Borough of Manhattan

R-W Screen Effluent discharging into Hudson River.

East

PLAINFIELD, N.J.

R-W Screen operating before Imhoff Tanks.

THE SANITATION CORPORATION
NEW YORK CITY

Modern Sewage Treatment

SEWAGE TREATMENT PLANTS

South

DAYTONA, FLA.

R-W Screen
Effluent discharging into Halifax River.

West

SANTA BARBARA, CAL.

R-W Screen operating adjacent to ocean boulevard. Plant indicated by arrow.

THE SANITATION CORPORATION

NEW YORK CITY

Read, Frank C., Head Chemist, Rep. Standard Oil Company of Louisiana Box 249, Baton Rouge, La.

Reed, T. H., Superintendent of Southern Division, Rep. The Texas Co., Asphalt Dept., 1310 Heard National Bank Building, Forsyth and Laura Sts., Jacksonville, Fla.

Reilly, P. C., Pres., Rep. Republic Creosoting Co., Merchants Bank Building, Indianapolis, Ind.

Renkert, O. W., President, Rep. National Paving Brick Manufacturers' Association, Renkert Building, Canton, O.

REPUBLIC CREOSOTING COMPANY, Merchants Bank Bldg., Indianapolis, Ind.
P. C. Reilly, President, Merchants Bank Bldg., Indianapolis, Ind.
A. E. Larkin, 828 Plymouth Bldg., Minneapolis, Minn.
L. E. Hess, Merchants Bank Building, Indianapolis, Ind.

Reynolds, S. G., Atlanta Branch Manager, Rep. Birmingham Slag Company, 64 Marietta St., Atlanta, Ga.

Richardson, Clifford, Consulting Engineer, Rep. The Barber Asphalt Paving Co., 1615 Woolworth Building, New York City.

Robinson, E. M., Rep. Warren Bros. Co., Nashville, Tenn.

ROCKPORT GRANITE COMPANY, Rockport, Mass.................. 1915
C. Harry Rogers, Rockport ,Mass.

RODD COMPANY, THE, Century Building, Pittsburg, Pa............... 1916
Smith D. Hicks, Century Bldg., Pittsburg, Pa.

Rogers, C. Harry, Rep. Rockport Granite Co., Rockport, Mass.

SAINT MARYS SEWER PIPE COMPANY, St. Marys, Pa.............. 1910

SANITATION CORPORATION, THE, 12th & Monmouth Sts., Jersey City N. J.. 1914
William L. D'Olier, Chief Engineer, 1533 Girard Ave., Philadelphia, Pa.
J. M. Kelly, Secretary 12th & Monmouth Sts., Jersey City, N. J.

Schutte, August E., Consulting Chemist, Rep., Warren Brothers Co., 9 Cambridge St., Boston, Mass.

Sharples, Philip P., Mgr. Gen. Tarvia Dept., Rep. The Barrett Co., 17 Battery Place, New York City.

Sheidler, P. K., Manager Paving Department, Rep., The Barrett Company, Cleveland, O.

Shelley, H. T., Rep. Eastern Clay Products Asso., 514–5 Pittsburg Life Bldg., Pittsburg, Pa.

Sherman, J. S., Chief Municipal Sewage Section, Sanitary Engineering Department, Rep., The Dorr Co., 101 Park Ave., New York City.

Sherrick, Edward D., Assistant Superintendent Asphalt Sales Dept., Rep., The Texas Company, 210 Dwight Bldg., Kansas City, Mo.

SINCLAIR REFINING COMPANY, 111 W. Washington St., Chicago, Ill. 1920
J. M. Woodruff, Manager Asphalt Sales Department, 111 W. Washington St., Chicago, Ill.
Geo. O. White, 1674 South Parkway, E., Memphis, Tenn.

Smith, Arthur C., Chief Engineer, Rep., Sucher Wood Process Co., 131 Church St., Wallingford, Conn.

Smith, B. M., Manager Paving Department, Rep. The Barrett Company, 10 S. LaSalle St., Chicago, Ill.

SOUTHERN ASPHALT ASSOCIATION, 419 Healey Building, Atlanta, Ga.. 1919
J. A. Cassidy, Secretary-Treasurer, 419 Healey Bldg., Atlanta, Ga.

Spencer, Herbert, Engineer, Asphalt Department, Rep., Standard Oil Company (New Jersey), 26 Broadway, New York.

STANDARD OIL COMPANY OF KENTUCKY, Louisville, Ky.......... 1919
James D. Clark, Assistant Vice-President, Louisville, Ky.

STANDARD OIL COMPANY OF LOUISIANA, Whitney Central Building New Orleans, La... 1915
J. S. Helm, Whitney Central Building, New Orleans, La.
Frank C. Read, Head Chemist, Box 249, Baton Rouge, La.

STANDARD OIL COMPANY (NEW JERSEY), 26 Broadway, New York.
Porter S. McCormick, Asphalt Rep., Baltimore, Md.
Herbert Spencer, Engineer Asphalt Department, 26 Broadway, New York City.

STANDARD OIL COMPANY OF NEW YORK, Room 600, 26 Broadway, New York City.......... 1913
Henry Fisher, Manager Road Oil Department, Room 600, 26 Broadway, New York City.
Frank T. Fay, Sales Agent Road Oil Department, 50 Congress St., Boston, Mass.
Wm. D. Craven, Jr., Engineer Asphalt Pavement & Road Construction, 1306, 26 Broadway, New York City.

Stewart, S. W., Pres., Rep.. Ambursen Construction Co., 186 Fifth Ave., New York City.

SUCHER WOOD PROCESS COMPANY, 131 Church St., Wallingford, Conn.......... 1920
Arthur C. Smith, Chief Engineer, 131 Church St., Wallingford, Conn.

SUPERIOR GARBAGE INCINERATOR COMPANY OF TEXAS, Praetorian Building, Dallas, Texas.......... 1919
H. E. Burns, Praetorian Building, Dallas, Texas.

Tefft, G. H., Secretary and General Manager, Clay Products Association, 913 Chamber of Commerce, Chicago, Ill.

Tenney, George O., President, Rep., Atlantic Bitulithic Company, 1205 Virginia Railway and Power Building, Richmond, Va.

TEXAS BITULITHIC COMPANY, Praetorian Building, Dallas Texas..... 1908
Alfred H. Johnson, President, Praetorian Bldg., Dallas, Texas.

TEXAS COMPANY, THE, Asphalt Sales Department, 17 Battery Place, New York City.......... 1911
W. H. Kershaw, General Manager, 1904 Whitehall, Bldg., 17 Battery Place, New York City.
John J. Gartland, Jr., Superintendent Eastern Division, Whitehall Bldg., 17 Battery Place, New York City.
Dennis A. Kennedy, Superintendent of New England Division, 714 Tremont Bldg., 73 Tremont St., Boston, Mass.
T. H. Reed, Superintendent of Southern Division, 1310 Heard National Bank Bldg., Forsyth and Laura Sts., Jacksonville, Fla.
E. D. Sherrick, 210 Dwight Bldg., Kansas City, Mo.
James T. Ware, Superintendent of Western Division, 212 Dwight Bldg., Tenth and Baltimore Sts., Kansas City, Mo.
F. V. Widger, Superintendent of Middle West Division, 540 Otis Bldg., 10 S. LaSalle St., Chicago, Ill.
W. L. Hempelmann, Engineer of Middle West Division, 540 Otis Bldg., 10 S. LaSalle St., Chicago, Ill.
A. R. Young, Chief Engineer, Asphalt Sales Department, 212 Dwight Bldg., Tenth St. and Baltimore Ave., Kansas City, Mo.
R. R. Barrett, Engineer of Eastern Division, 1904 Whitehall Bldg., 17 Battery Place, New York City.
Louis W. Kemp, Superintendent Southwestern Division, Houston, Texas.
R. M. Elder, 540 Otis Building, Chicago, Ill.
C. E. Murphy, 17 Battery Place, New York City.

Thompson, Philip L., Sales Mgr., Rep. Hastings Pavement Co., 25 Broad St., New York City.

Thurston, George W., Secretary, Rep. Western Paving Brick Manufacturers' Association, 317 Dwight Building, Kansas City, Mo.

Tobin, J. J., Rep. Granite Paving Block Manufacturers Association, 31 State St., Boston, Mass.

Tomlin, R. K., Managing Editor, Rep. Engineering News-Record, 10th Ave. and 36th St., New York City.

Travilla, J. C. Consulting Engineer, Rep. Dunn Wire-Cut Lug Brick Company, Room 1018, 211 N. 7th St., St. Louis, Mo.

Blackmer & Post Pipe Co.

Saint Louis, U. S. A.

We manufacture all sizes of
Sewer Pipe, 4 to 42 in.
in diameter.

Write us for prices and
other information
desired.

Turner, R. W., Vice-President, Rep. Warren Bros. Co., 50 Church St., New York City.

UNITED GAS IMPROVEMENT COMPANY, THE, 1706 N. Broad St., Philadelphia, Pa. 1913
W. H. Fulweiler, Chemist, 1706 N. Broad St., Philadelphia, Pa.

UNITED STATES ASPHALT REFINING COMPANY, THE, 90 West St., New York City 1913
J. R. Draney, General Sales Manager, 90 West St., New York City.

UNIVERSAL PORTLAND CEMENT COMPANY, 210 S. LaSalle St., Chicago, Ill. 1913
J. H. Libberton, Manager Service Bureau, 210 S. LaSalle St., Chicago, Ill.

Valk, James R., Manager Asphalt and Road Oil Dept., Carson Petroleum Co., 208 S. LaSalle St., Chicago, Ill.

Walcott, E. L., Rep. Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill.

Wandell, Mortimer, D., Vice-President, Rep., New York Trap Rock Corp., 101 Park Ave., New York City.

Ware, James T., Superintendent of Western Division, Rep. The Texas Co., Asphalt Sales Dept., 212 Dwight Bldg., Tenth St. and Baltimore Ave., Kansas City, Mo.

WARNER-QUINLAN ASPHALT COMPANY, 79 Wall St., New York City 1913
W. D. Baker, 79 Wall St., New York City.

WARREN BITUMINOUS PAVING COMPANY, Toronto, Ont., Canada. 1919
W. G. Mackendrick, President Toronto, Ont., Canada.

WARREN BROTHERS COMPANY, Parkman Bldg., 9 Cambridge St., Bowdoin Square, Boston, Mass. 1905
H. L. Alley, 9 Cambridge St., Boston, Mass.
Frank G. Cutter, Assistant to President, 848 Otis Bldg., Chicago, Ill.
J. E. Donelson, Birmingham, Ala.
James M. Head, Attorney, 9 Cambridge St., Boston, Mass.
J. Merrick Horn, Ford Bldg., Wilmington, Del.
Pardon S. Kaull, Vice-President, Railway Exchange Building, St. Louis, Mo.
J. H. Lippincott, 50 Church St., New York City.
C. L. Newbold, 1859 Railway Exchange, St. Louis, Mo.
G. Howard Perkins, Assistant to President, 9 Cambridge St., Boston, Mass.
E. M. Robinson, Nashville, Tenn.
August E. Schutte, Consulting Chemist, 9 Cambridge St., Boston, Mass.
R. W. Turner, Vice-President, 50 Church St., New York City.
George C. Warren, President, 9 Cambridge St., Boston, Mass.
Ralph L. Warren, Secretary, 9 Cambridge St., Boston, Mass.

Warren, George C., President, Rep., Warren Brothers Company, 9 Cambridge St., Boston, Mass.

Warren, Ralph L., General Manager, Rep., Warren Brothers Company, 9 Cambridge St., Boston Mass.

WESTERN PAVING BRICK MANUFACTURERS' ASSOCIATION, 317 Dwight Building, Kansas City, Mo. 1912
George W. Thurston, Secretary, 317 Dwight Building, Kansas City, Mo.
Clark R. Mandigo, Engineer, 317 Dwight Building, Kansas City, Mo.

White, George O., Rep. Sinclair Refining Co., 1674 South Parkway E., Memphis, Tenn.

Widger, F. V., Superintendent of Middle West Division, Rep. The Texas Co., Asphalt Sales Dept., 540 Otis Bldg., 10 S. LaSalle St., Chicago, Ill.

Wiley, Rodman, Chief Engineer, Rep., Kentucky Rock Asphalt Co., Paul Jones Bldg., Louisville, Ky.

Williams, Roger W., Rep., George W. Lamson, 811 Railway Exchange Bldg., Chicago, Ill.

PUBLIC WORKS

Is the New Name of Municipal Journal

Mr. A. Prescott Folwell, past president, and for a number of years the Secretary of the A. S. M. I. is the editor.

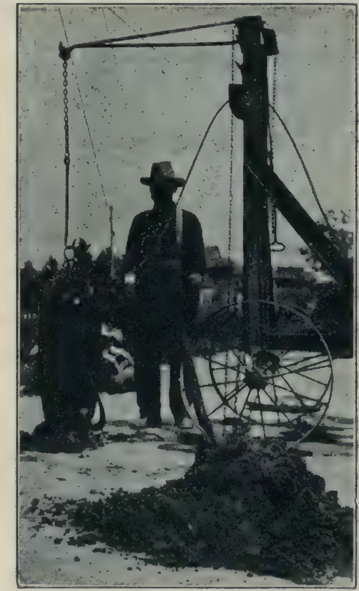
The new name is comprehensive, easy to remember and prevents confusion with other papers.

It is issued weekly and devoted to the design, construction, maintenance and news of public work. The main subjects covered, are, paving, sewerage, sewerage disposal, water supply, bridges and all other questions in which city engineers and heads of departments are interested.

Subscription price $3 a year.

Publication Office

243 WEST 39th ST. NEW YORK CITY



I Want a Job
Cleaning Sewers

My qualifications—age—experience—and reference will be cheerfully given upon request.

I can handle the hardest jobs—tough jobs—and dirty jobs—that others won't tackle.

My jaws open wide and I simply smile when dirty water—filthy sand—carbolic acid—and black muck, are flung in my face.

I can swallow old rubber—dirty rags—rotten paper—black muck—and old shoes—without losing my appetite.

When do I get the job? Write at once.

Yours for hard jobs,

Kuhlman Sewer Cleaning Machine

Manufactured by

The CHAMPION CORPORATION, Dept. S, Hammond, Ind.

Wood, E. C., Rep. Barber Asphalt Paving Co., St. Louis, Mo.
Woodruff, J. M., Manager, Asphalt Sales Dept., Rep., Sinclair Refining Co., 111 W. Washington, St., Chicago, Ill.

Young, A. R., Chief Engineer, Asphalt Sales Dept., Rep. The Texas Co., 212 Dwight Bldg., Tenth St. and Baltimore Ave., Kansas City, Mo.

CHANGES IN MEMBERSHIP

The following changes in membership have been made since the lists on pages 307 and 310 were prepared.

ADDITIONS

ACTIVE

Julius Adler	Philadelphia, Pa.
Edwin Ball	Newark, N. J.
H. Eltinge Breed	New York City
E. E. Butterfield	Long Island City, N. Y.
Jas. E. Carroll	St. Paul, Minn.
Edward S. Clark	Kalamazoo, Mich.
Oscar Claussen	St. Paul, Minn.
Z. G. Crane	West Caldwell, N. J.
H. J. Darcey	Oklahoma City, Okla.
A. Clinton Decker	Fairfield, Ala.
Wm. O. Drake	Corning, N. Y.
James L. Ferebee	Milwaukee, Wis.
E. L. Filby	Columbia S. C.
F. X. Friedrich	Joliet, Ill.
Charles Frommer	Philadelphia, Pa.
E. R. Gray (reinstated)	Hamilton, Ont.
J. H. Gregory	Baltimore, Md.
C. D. Hill	Chicago, Ill.
Henry C. Hines	Newark, N. J.
Harold R. Holmes	Lockport, N. Y.
Albert H. Jewell	Lawrence, Kan.
J. A. Lalonde	Outremont, Que.
E. T. Lewis	Nashville, Tenn.
Philip Lindeman	Newark, N. J.
F. O. Lindsley	East Orange, N. J.
F. C. Lingelfelter	Indianapolis, Ind.
H. V. Macksey	Franingham, Mass.
Lowell W. Monroe	Meadville, Pa.
R. B. Morse	Baltimore, Md.
William Mungle	Newark, N. J.
J. H. Nevitt	Toronto, Ont.
P. C. Painter	Washington, N. C.
O. A. Seward, Jr	Beaumont, Tex.
W. W. Southgate	Nashville, Tenn.
D. J. Sweeney	Buffalo, N. Y.
W. S. Tomlinson	Columbia, S. C.
N. T. Veatch, Jr	Kansas City, Mo.
Joseph C. Wagner	Philadelphia, Pa.
J. J. Wells	Rocky Mount, N. C.
Herman C. Wenzel	St. Paul, Minn.
Chas. E. White, Jr	Oak Park, Ill.
J. W. Woermann	St. Louis, Mo.

AFFILIATED

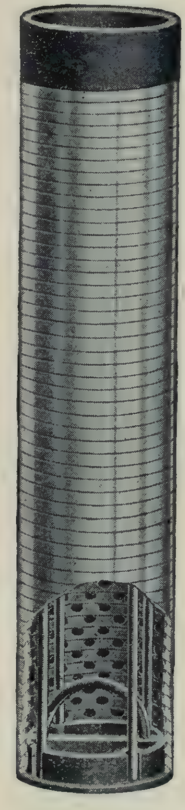
Earl A. Anderson	E. Cleveland, O.
James W. Follin	Philadelphia, Pa.

JOHNSON

"The Screen with the continuous inlet slot."

BRASS WELL SCREENS

For wells ending in sand and gravel



CAPACITY

JOHNSON BRASS WELL Screens have a larger intake capacity than any other brass screen made. 100% of the circumference of the tube is utilized, as against 66% in all other kinds. This 50% additional costs the user nothing.

Specify lineal feet of intake, instead of so many feet of screen and save your client's money.

SHAPE OF INTAKE SLOT

Is it news to you that the only completely undercut slot to be found in a brass well screen is that of the JOHNSON? It's true. The bevel assists materially in keeping the intake slot open during the development of the well, as it allows any sand which passes the lips of the slot to pass clear thru easily and be pumped out.

For your client's benefit and your own ease of mind be sure that your recommendations call for a slot chamfered clear to the outside wall of the screen.

STRENGTH

JOHNSON BRASS WELL SCREENS are, in effect, composed of two walls. The inner for strength and the outer for intake surface. Varying the outer wall does not affect the inner. Thus we can make a JOHNSON Brass Well Screen with a No. 50 slot, and the screen will be just as strong to withstand radial compression as one with a No. 4. In this feature the Johnson screen is unique.

Include it in your specifications.

Our brass screen catalogue No. 16 and pipe base screen catalogue No. 18 contain much data and are interesting to those who are engaged in well work. Ask for them.

EDWARD E. JOHNSON, INC.

2304 Long Avenue St. Paul, Minn.

Samuel C. Hadden	Indianapolis, Ind.
Helen M. Johnson	Galesburg, Ill.
Harold G. Schutt	Lindsay, Cal.
F. O. Farey (transferred from Associate to Affiliated)	Montreal, Que.

ASSOCIATE

H. F. Ahrens	Ampere, N. J.
Harvey L. Alley	Boston, Mass.
Ambursen Construction Co., S. W. Stewart, Rep	New York City
American Tar Products Co., W. E. Crowell, Rep	Columbus, O.
Asphalt Sales Corporation, H. J. Gillum, Rep	Chicago, Ill.
C. L. Campbell	St. Louis, Mo.
W. H. Caruthers	St. Louis, Mo.
Cincinnati Quarries Co., Geo. W. Doran, Rep	Cincinnati, O.
Cressy Road Sprayer Co., R. Pebworth, Rep	Everett, Mass.
W. W. DeBerard	Chicago, Ill.
W. S. Dickey Clay Mfg. Co., W. S. Dickey, Rep	Kansas City, Mo.
Dow Chemical Co., S. W. Putnam, Rep	Midland, Mich.
Eastern Clay Products Association (change of name from Vitrified Pipe Mfg. Asso.) H. T. Shelley, Rep	Pittsburg, Pa.
C. R. Ege	Chicago, Ill.
Hastings Pavement Co., P. L. Thompson, Rep	New York City
R. G. Hunt	Salisbury, N. C.
C. L. Newbold	St. Louis, Mo.
E. H. Peters	Chicago, Ill.
O. W. Renkert	Canton, O.
P. K. Sheidler	Cleveland, O.
E. D. Sherrick	Kansas City, Mo.
Sucher Wood Process Co., Arthur C. Smith, Rep	Wallingford, Conn.
George O. White	Memphis, Tenn.

DEDUCTIONS

RESIGNATIONS

Active

F. H. Clark	Framingham, Mass.
A. W. Dean	Winchester, Mass.
John Dymond, Jr	New Orleans, La.
R. D. Hennen	Morgantown, W. Va.
Ernest McCullough	Syracuse, N. Y.
H. N. Roberts, Jr	Longview, Tex.
E. F. Scattergood	Los Angeles, Cal.
E. W. Stern	New York City
J. E. Thier	Hackensack, N. J.

Affiliate

Mabel Inness	Galesburg, Ill.

Associate

Brandeis Machinery and Supply Co., J. A. Paradis, Rep	Louisville, Ky.
Robert W. Hunt and Co., J. H. Campbell, Rep	Chicago, Ill.
Standard Asphalt and Refining Co., Charles Muller and E. K. Carter, Reps.	Chicago, Ill.

TRANSFERRED

F. O. Farey from Associate to Affiliated.

Vitrified Pipe Manufacturers Association to Eastern Clay Products Association.

MUNICIPAL DELEGATES NOT REAPPOINTED

Frederick Adams	Newark, N. J.
William Cardwell	E. Orange, N. J.
F. H. Caven	Philadelphia, Pa.

LACLEDE STEEL COMPANY

MANUFACTURERS

CONCRETE REINFORCEMENT BARS

Deformed Squares — Plain Squares
Deformed Rounds — Plain Rounds

Twisted Squares

Sizes: ⅜", ½", ⅝", ⅞", 1", 1⅛", 1¼"

Bent and Fabricated at Mills if Desired

General Offices:
ARCADE BUILDING, ST. LOUIS, MO.

Chicago Office:
208 S. LaSalle St.

Kansas City Office:
228 Scarritt Bldg.

ROBERT W. HUNT — JNO. J. CONE — D. W. McNAUGHER

ROBERT W. HUNT & CO.

Engineers

INSPECTION - TESTS - CONSULTATION

Inspection and Test of Paving, Brick, and Creosoted Block at Manufacturing Plants

Mill and Shop Inspection Structural Steel for Bridges and Structures

Inspection and Testing of Cement at Mills

Inspection of Cast Iron Pipe at Foundries

Resident Inspectors at Manufacturing Plants and Mills

CEMENT, CHEMICAL AND PHYSICAL LABORATORIES

NEW YORK — CHICAGO — PITTSBURGH

St. Louis — Kansas City — Dallas — San Francisco
New Orleans — Jacksonville — Cincinnati — Seattle
London — Montreal — Vancouver — Toronto

C. E. Davis	Philadelphia, Pa.
A. W. Harrison	Livingston, N. J.
A. L. Lacombe	Irvington, N. J.
J. O. Magruder	Danville, Va.
E. E. Ryman	Newark, N. J.
C. R. Swain	Newark, N. J.
G. S. Webster	Philadelphia, Pa.

REPRESENTATIVES OF ASSOCIATE MEMBERS NOT REAPPOINTED

W. T. Blackburn	Paris, Ill.
F. W. Cherrington	Toledo, O.
H. C. Ehrenfels	New Orleans, La.
E. D. Gray	Toronto, Ont.
W. M. Kinney	Chicago, Ill.
J. B. Klunk	Toledo, O.
K. Lydecker	New York City
E. D. McCall	Salisbury, N. C.
F. E. Parker	Lansing, Mich.
J. L. Rice	Akron, O.

DECEASED

Active

Matthew Gault	Worcester, Mass.

Associate

G. M. Ingram	Nashville, Tenn.
J. C. Rock	New York City

MAIL RETURNED UNDELIVERED

Active

S. D. Newton	Cleveland, Tenn.

Affiliated

T. P. Johnston	New Orleans, La.

Associate

W. A. Hogue	Charleston, W. Va.

DROPPED

Active

O. J. S. Ellingson	Sherman, Tex.

Associate

Walter H. Van Winkle, Jr.	New York City

AUTOMATIC Sewer Main Flushing—

Is automatic, is reliable, is low in maintenance, is easy to install if you use **MILLER SIPHONS**

Their design makes them work automatically. They have only two parts—neither of which move. They are well made—with nothing to wear out. The two parts are fitted and easy to set.

Ask for catalog No. 14, which is so complete an authority on sewage disposal it is used as an engineering text-book.

THE PACIFIC FLUSH-TANK CO.
4241-3 E. Ravenswood Ave., Chicago, Ill.
149 Broadway, New York

Highway Iron Products Company
LIGONIER, INDIANA

MANUFACTURERS OF TRAFFIC AND STREET SIGNS

Send for our latest catalog covering our line of Traffic Signs

ALVORD, JOHN W. **BURDICK, CHAS. B.**
Consulting Engineers
Reports, Investigations, Plans and Specifications for Water Supplies, Water Purification, Water Power, Sewerage, Sewage Disposal
Hartford Building, Chicago

BLACK & VEATCH, Consulting Engineers
Mutual Building, Kansas City, Mo.
Water Supply, Water Purification, Sewerage, Sewage Disposal, Power Plants, Valuations, Special Investigations and Reports
E. B. BLACK **Associates** N. T. VEATCH, JR.
A. P. Learned, I. S. Siegrist, E. H. Dunmire, J. F. Brown, C. A. Haskins

George W. Fuller
J. R. McClintock
J. K. Giesey
Fuller & McClintock
New York City
170 Broadway
Consulting Hydraulic Engineers and Sanitary Experts
Water Supply and Purification, Sewerage and Drainage, Disposal of Sewage and Refuse, Investigations of Epidemics, Public Utility Valuations, Supervision of Construction and Operation

ALEXANDER POTTER
Consulting Engineer
Hydraulics, Sanitation, Concrete Structures
50 Church St. Telephone 5501, Cortlandt NEW YORK

197915

American Society of Municipal Engineers
Official proceedings
1920

P
Tech
A

DATE
NAME

University of Toronto
Library

DO NOT
REMOVE
THE
CARD
FROM
THIS
POCKET

Acme Library Card Pocket
Under Pat. "Ref. Index File"
Made by LIBRARY BUREAU